SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

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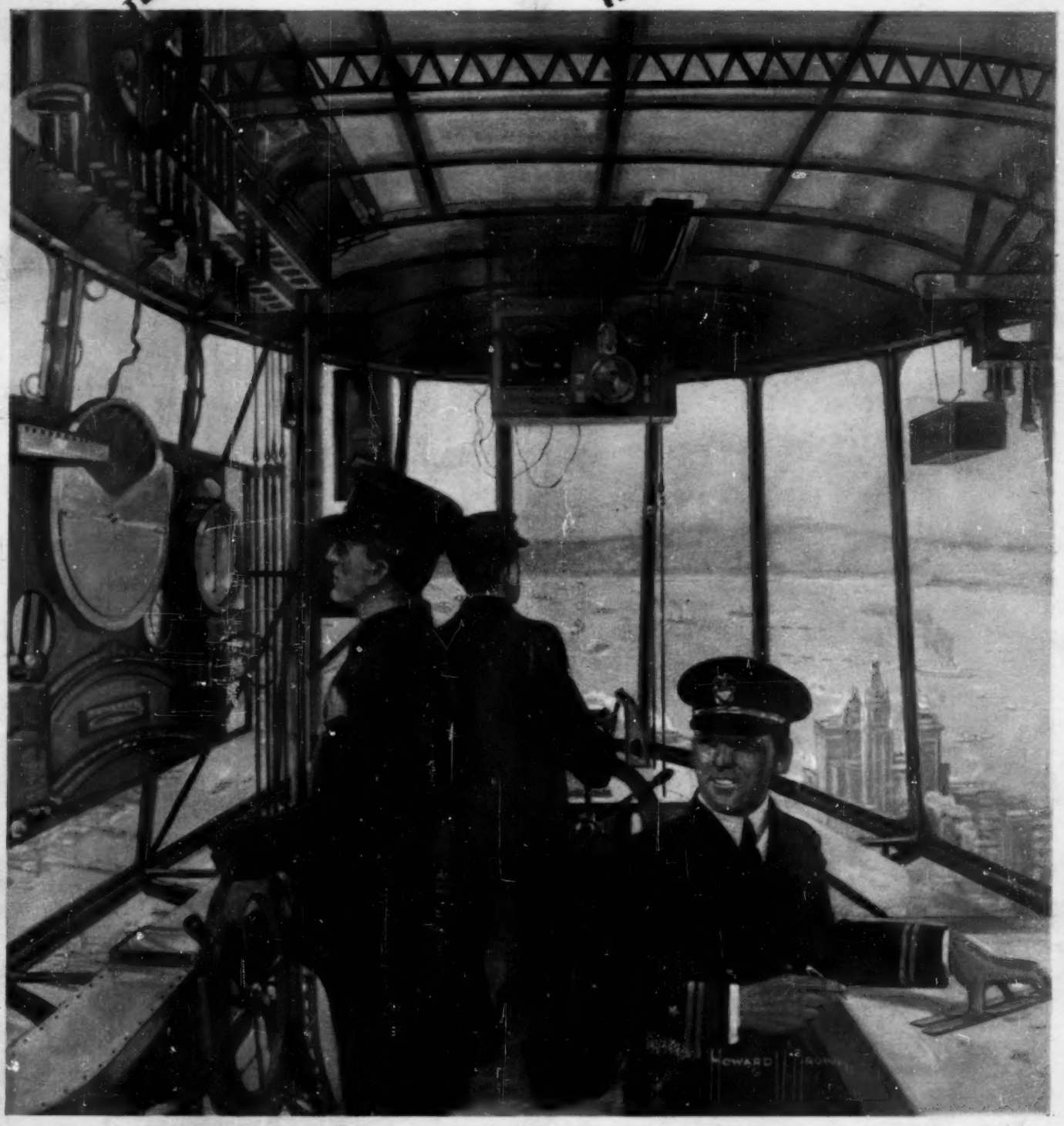

IN THE NAVIGATING ROOM OF THE U. S. NAVY DIRIGIBLE "SHENANDOAH."—[See page 82]

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With the Editors

ONE of the functions of the editorial staff of any journal of standing is the answering of inquiries. Between the questions asked of a given editor, and the field which his paper covers, there exists a distinct relation. The magazine of detective-story fiction is asked how to become a detective and how to catch a suspected wrong-doer; the journal of bee culture is asked questions on keeping bees and marketing honey. We ourselves, unable to define our field any more closely than by use of the word "science," with more or less emphasis on the adjective "applied," are asked questions about every serious and near-serious topic under the sun.

HOW can I keep the ground water from seeping through the cement of my cellar? What is the cause of the lateral drift of projectiles? What book would you recommend for an elementary study of the elliptic functions? What is the present manufacturing cost of helium under the best conditions? Does the divining rod really work? Will a packing of sand conduct sound? Is there, in general use in the United States, a welding process notably superior to those current in England? How much heat and light does the earth receive from Jupiter? How can I bore holes in glass without breaking it? What is the difference between the several species of horsepower which one finds quoted, and how is each calculated? How many prime numbers are there, and is there any simple factor test for large numbers? What are the formulæ for the paste and the electrolyte in a storage battery? What is the highest instantaneous speed ever developed by an airplane?

MOST of the people who ask us questions like these realize that we can't have the answers on our finger tips, and are content to wait while we dig them up. Others are not so easy to deal with. They call us up to propound a question which their own search and that of their librarian has failed to settle; and they are highly indignant when we do not give the answer instanter. The explanation that it has to be looked up, or that the member of the staff who could answer it without search is not at his desk, is rejected scornfully, and the voice on the other end of the wire expresses more or less explicitly its owner's feeling that we, who cannot answer out of our stored wisdom any question which he could possibly propound, in any department of science whatever, are decidedly out of place on the editorial staff of the SCIENTIFIC AMERICAN. This is very gratifying in so far as it reflects the esteem in which we, collectively, are held; but it is trying upon the individual editorial disposition.

WE have another grievance against some of those who query us. Most of them have significant questions on the [illegible] in which they are seriously interested. But there is always an appreciable residuum who ask trifling questions on trifling subjects. Every query editor has a dozen or so of these good old chestnuts, which come up three times a week, as regularly as the clock runs. We have had as many as five of them in one letter.

DID the "Titanic" reach the bottom, or does she swing suspended at an intermediate depth? If a bullet is shot from the back of a moving train, at a speed equal to that of the train, what happens to it? Who invented the automobile? If an explosion occurs with no person in earshot, is there any sound? How do we explain the cutting up of an eight-inch square into pieces that fit together into two rectangles with an apparent aggregate area of 65 square inches? All of these, as well as numerous others which we could cite, we have answered in and out of print on numerous occasions; but they keep right on coming. Their effect upon our time is serious, and on our temper even worse.

WELL: answering questions is part of our job, and on the whole we enjoy it. It constitutes a very real part of our service to our readers. But we hope for the millennium, in which no querist will out of idle curiosity ask us trivial and hackneyed questions; and in which every querist will first make a reasonable effort to find his answer for himself, and will then realize that his inability to find it at all is good indication that we can't give it offhand. If all these things would come true, the answering of our reader's questions would be a continual pleasure, instead of a pleasure mixed with periodic pain.

OF less spectacular interest than our psychic and Abrams investigations, but no doubt of greater practical value is our present campaign for the improvement of highway traffic conditions, which is represented in this issue by the article entitled "One Law vs. Forty-Eight." This campaign has for its purpose the study of traffic laws and regulations, highway facilities in various parts of the country, the traffic congestion in cities, grade crossings, and other features which concern everyone, whether an automobile driver or not. What with millions of passenger cars in operation and hundreds of thousands of motor trucks and buses, the highways play a most important rôle in our national life. Of late the number of accidents have been such as to attract undue attention, and it is evident that something must be done to make highway traffic safer than it is today. And if nothing is done, the existing difficulties will by no means right themselves, but rather will keep on augmenting. So, something must be done—and done quickly.

NOW this highway traffic matter varies from one part of the country to another, due to local conditions and local laws. Nevertheless, it must be considered in terms of the entire country, for it is a national problem and not purely a local one. It calls for an interchange of ideas. It is as necessary to hear from the motorist in California as it is to hear from the truck driver in New York. Indeed, we want to hear from everybody regarding existing difficulties in highway transport and highway travel, as well as any ideas which may be put forward by way of helping solve the existing problems. Let us put all our views and ideas together. Get in touch with us by addressing your letter to the Highway Traffic Editor.

IF the Abrams investigation now being conducted by this journal has accomplished nothing else as the result of four months of patient and unrelenting investigation, it has at least boiled down the claims of the E. R. A. (Electronic Reactions of Abrams) practitioners to a very modest basis as compared with the elaborate, if not fantastic, claims originally made for this new technique. Page 87 of this issue tells the story to date.

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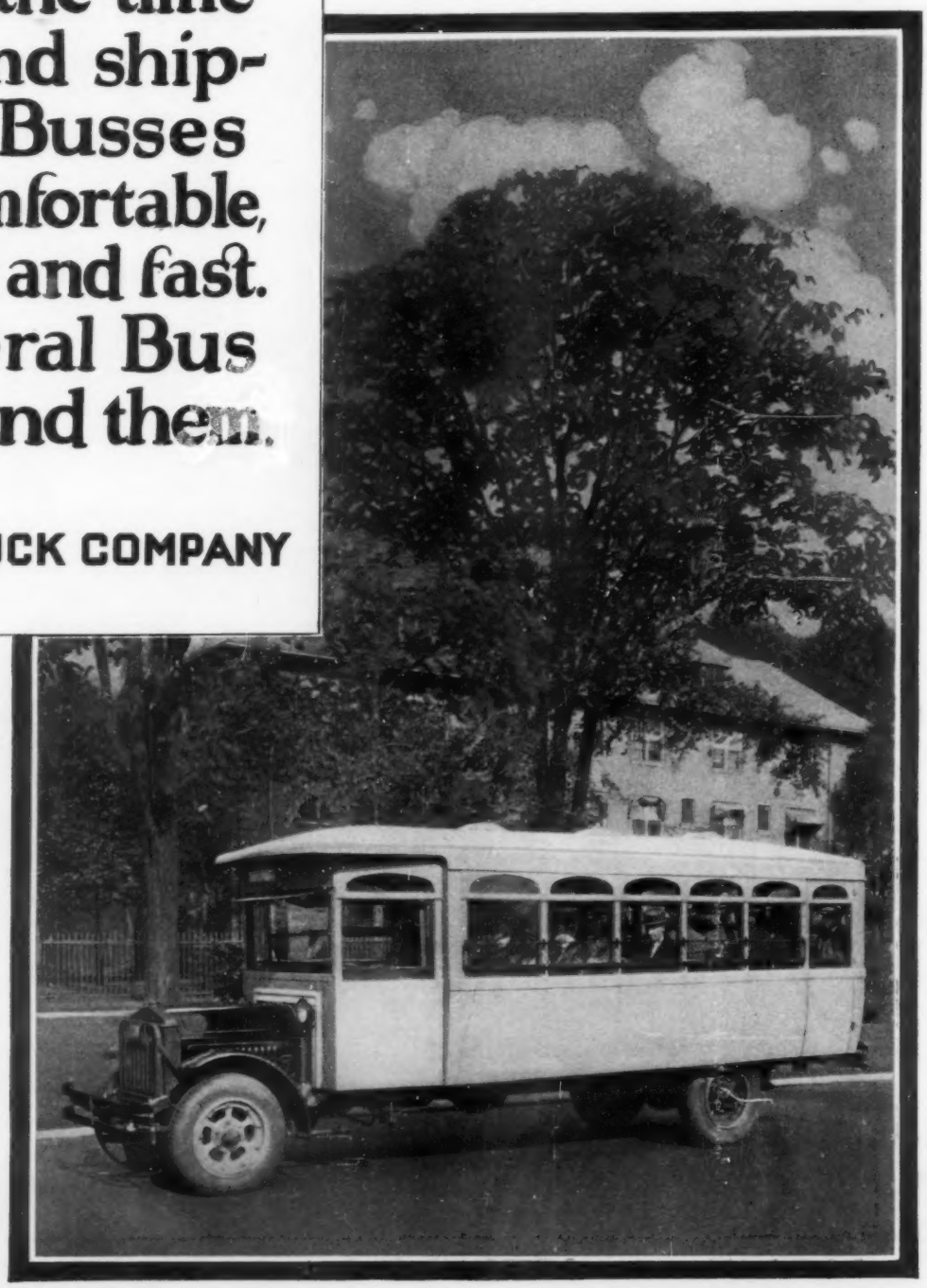

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SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, FEBRUARY, 1924

The Oldest Eggs in the World

A FEW months ago a cablegram from China announced perhaps the most curious find ever made in exploration. Roy Chapman Andrews was the leader of the Third Asiatic Expedition of the American Museum of Natural History, The American Asiatic Association, and *Asia Magazine*. It is through the courtesy of *Asia Magazine* that we are enabled to present, largely in Mr. Andrews' own words, the interesting facts of his discovery of a nest of dinosaur eggs.

A dinosaur was an ugly brute and would alarm even a grown-up, if we should see him stalking with the thin hatchet face, elongated neck, bony frame and thick tail. Even in restoration it is an awe-inspiring monster which no artist could evolve even from a diseased brain—the reality is much more horrible. Ten million years ago this strange creature existed on the edge of the shallow basin of Mongolia and slowly waddled down and settled into the sand and in a hollow left a number of eggs which fortunately for us, were never hatched by the heat of the sun.

Of course dinosaurs have been found in other parts of the world, but there has never been anything so spectacular in the whole history of paleontology as the discovery of these remarkable eggs. It is probable that the dinosaur migrated millions and millions of years ago through Siberia and across the land bridge to America, and spread inland to its western coast where the type grew to an enormous size and developed horns. Heretofore we have always thought that the fossil bones of *Triceratops* originated here. They appeared completely developed in the cretaceous rocks and gave no clue to their family tree. Mr. Andrews says that it was on a brilliant day in midsummer, ten million years after the reptile had made its nest in the sandy hollow, that the expedition pitched their tents on the rim of a great depression just below where the eggs were laid. Hundreds of feet of earth had drifted over them through the ages and by the action of wind, frost and rain, leaving them half exposed. Some showed only bits of broken shell, but four remained intact. They were no longer white, their long entombment had changed them to a delicate brown. The configuration of the country was vastly different from when the dinosaur laid the eggs. Of course the climate had altered enormously in the immense period intervening between the time the eggs were laid and when they were discovered.

Mr. Andrews, in his story in *Asia Magazine*, describes most interestingly the actual discovery of the fossil remains. It seems that the photographer wandered off to look at some earth ovens left by Mongols and much to his surprise he found that they were at the edge of a plateau that fell sharply away into a great basin. He decided to spend five minutes in looking for fossils before returning to the automobiles. Almost at once he discovered a small white skull, which was afterwards identified as an ancestor of the great horned dinosaur of America. The locality was worked over in the usual way and one of the party reported that he was sure he had found fossil eggs. This seemed so remarkable that the matter was turned over as a joke, but nevertheless it was agreed that they walk to where the alleged eggs had been discovered. Then their indifference suddenly evaporated for they realized that they were looking at the first dinosaur eggs ever seen by a human being. Mr. Andrews says: "We could hardly believe our eyes, but, even though we tried to account for them in every possible way as geological phenomena, there was no shadow of doubt that they really were eggs. That they must be those of a dinosaur we felt certain. True enough, it never was known before that dinosaurs did lay eggs, but, since most modern reptiles are oviparous, it was considered probable that their ancient ancestors followed this method of reproduction. Nevertheless, although hundreds of skulls and skeletons of dinosaurs had been discovered in various parts of the world, never had an egg been brought to light.

"These eggs could not be those of a bird. No birds are known from the Lower Cretaceous, the geological horizon in which the eggs were found, and all the Jurassic and Upper Cretaceous birds were much too small to have laid eggs of this size. The elongate shape of the eggs is distinctly reptilian. A bird's egg usually is much larger at one end than at the other, because it is deposited in a nest, from which it might roll out unless it revolved on its point. Reptile eggs, which often are buried in the earth or sand, usually are elongate and similar in shape to the specimens that we found. These eggs were in a great deposit full of dinosaur skeletons and containing, so far as we could discover, no remains of other animals or of birds.

"Three of the eggs lay in a cluster and evidently were in the exact spot where they had been deposited by the dinosaur. The broken shells of several others were partially embedded in the rock. Just under a low sandstone shelf, beside which they were lying, we could see the projecting ends of two others. While all the members of the Expedition were on their hands and knees about those ten-million-year-old eggs, George Olsen began to scrape away the loose rock on the summit of the shelf, and to our amazement he uncovered the skeleton of a small dinosaur, lying eight or ten inches above the eggs. Was it the reptile that had laid the eggs or was it a predatory dinosaur that had come to feed upon them? We cannot tell, but we like to think that some sudden catastrophe overtook the actual egg-layer, while on a visit to its nest.

"We believe that the eggs were buried in fine silt or sand, which would be peculiarly suitable for the preservation of delicate objects. This place may have been low ground, over which the waters of a river would spread during flood-time, but running-stream action could not have taken place here or the eggs would have been rolled about, separated and inevitably broken. Personally, I believe that they were buried in light sediment carried over them by the wind. The first specimens found by George Olsen are about eight inches in length and seven inches in circumference. They are rather more elongate and flattened than is usual in the case of modern reptile eggs and very much longer than the eggs of any known bird.

"The preservation is beautiful. Some of the eggs have been crushed, but the pebbled surface of the shells is as perfect as if the eggs had been laid yesterday instead of ten million years ago. The shells are about one-sixteenth of an inch thick and probably were hard and not membranous. Fine sand has filtered through breaks, and the interior of all the eggs is solid sandstone. In the photographs the bits of broken shell partially embedded in the rock are plainly to be seen, and it needs no stretch of imagination to realize that the objects pictured are really eggs. In fact, we tried our best to think of any geological phenomena that could have produced a similar result, but try as we would, we could never get away from the fact that 'eggs is eggs' and that these were laid by a dinosaur."

A few days after the first discovery five eggs were found in a cluster. Altogether 25 eggs were taken out and not all of them have been brought to this country as yet. Further examinations show that there were a number of species of dinosaur eggs and most interesting of all was the fact that in several of the eggs that had been broken in half there could be plainly detected the delicate bone of the embryonic dinosaurs. Never before in the history of science has it been possible to study paleoembryology. Baby dinosaurs that had probably been hatched only a few weeks and others in all stages of growth up to the adults ten feet long, were also discovered as fossil remains. Certainly Mr. Andrews has to be congratulated on the most remarkable discovery ever made in the history of paleoembryology.

Copyright Asia Magazine and American Museum of Natural History

Roy Chapman Andrews examining one of the eggs

Copyright Asia Magazine and American Museum of Natural History

A "close-up" of a Dinosaur egg perhaps ten million years old

The Romance of the Lock

Its Development, and the Means Employed to Beat It, From the Earliest Days

By Edward H. Smith

LOVE and larceny laugh at locksmiths. There may be an alliterative overburden in the paraphrase but there is no divagation from truth. Whether passion or cunning shall laugh last—Eros or Autolykos—who shall say? For the present, however, the god of theft laughs longer, louder and better. The barriers his children break are the substantial ones; less fabulous than love's but more rewarding. We may neglect this mirth of lovers and consider that of thieves.

To trace this ribaldry to its origins might lead us into too deep and distant peregrinations; besides there is enough to engage our attention in the present and the immediate past.

Late in the hot morning of September 25, 1865, two men drove into the historic town of Concord, Mass., in an old phæton behind a sorrel mare, drew up before the Concord National Bank and blithely committed one of the truly monumental pieces of lock defying. Their names were Langdon W. Moore—of whom previous mention—and Harry Howard. The evil that they did has, as you see, lived after them. Indeed, the crime they committed, so airily and openly, in the white sunlight of that autumnal noon, may be said to constitute one of the decisive engagements between the makers and breakers of locks, and it is therefore an important page from the endless story of burglary.

The Concord National Bank, an old and conservative institution, then considered itself well protected with a chilled iron vault, whose entrance was guarded by double doors of the same material, and an interior burglar proof chest of special construction. Five keys were required to release and open the outer door of the vault; two opened the inner doors and two more were needed to get into the chest. The locks were of the kind called warded, a term which will be explained later. They were of most complicated design and finest English manufacture—a detail which was then considered distinctive and reassuring, albeit English locks sprang into sudden disrepute immediately after the ensuing crime and continue to this day to be regarded with slight esteem in America.

Langdon Moore, who lived in the neighboring village of Natick, noticed, while visiting in Concord one day, that the cashier of the Concord Bank, locked up his institution at noon and went home to his luncheon, remaining away until half past 1 or 2 o'clock. On this chance observation the great robbery was founded. Moore, the idea of the burglary forming in his mind, returned to Concord and observed the habits of the other business people along the main street, near the bank. He saw that they, too, went home for the midday meal at 12 and remained absent at least an hour, leaving their shops and offices locked or in charge of solitary clerks. The business center of Concord was, thus, almost deserted for this interval. The circumstance spelled opportunity.

Moore, who divided his time between the farm at Natick, where he was accepted as a respectable gentleman, and New York, where he was already a noted member of the professional underworld with the false name of Charlie Adams, had never before robbed a bank—an oversight for which he made amends later on, becoming before his death one of the most celebrated of our older vauriens. In spite of his then inexperience, he saw what the officers of the bank had failed to realize, namely that whatever can be locked by one man may be unlocked by another, if he have the genius and the persistence for the essay. He summoned to his aid the man called Howard, really Henry Hauck, an errant German locksmith turned burglar. To Hauck he explained his plan and disclosed the details of the bank's equipment, which he had gathered by visiting the institution to get money changed and to negotiate a purchase of bonds.

A few nights after the arrival of his confederate, Adams went to the bank and examined the lock on the street door. He inserted a blank key of a size to fit the keyhole, having first taken the trouble to coat the key lightly with wax. By turning the blank against the inner mechanism of the lock the wards naturally impressed their position or outlines on the soft wax, and this "map" of the "works" was carried away. Howard fashioned the key to fit and the prospective burglars returned to the bank on a subsequent evening to have their try. Their key did not work, so Howard got a ladder and by its help reached the rear windows of the bank which, I have neglected to record, was situated on the second floor of the building, over the offices of a real estate firm.

Descending to the street door, Howard removed the bolts and took off the lock. It was found that a special metal tongue prevented the opening of the lock with the improvised key. This bit of metal was filed away and the lock put back into position. Now the key did the work. The first stage of the burglary was accomplished.

On the same night the plotters took an impression of the lock on the second floor, which fastened the door leading into the banking rooms. A second key was improvised to suit this pattern. On a convenient dark night the scheming pair returned, opened the street door with their first key, found that their second key worked the lock of the door upstairs and so had won their way to the vault. But here they met decided obstacles. The five keyholes of the outer door were of no ordinary design and attempts to make impressions through them were fruitless.

But the resourceful Moore was not foiled. He left his confederate on the farm at Natick and went traveling in quest of the American agents for the English vaults used in the Concord Bank. He found them in Boston, with one of the doors of the five keys in the showroom for exhibition purposes. Moore plausibly represented himself as a broker and dealer in securities, with the result that the agent carefully explained the workings of the locks, showed him and let him use the keys, outlined the special tricks that foiled burglars and gave Moore every shred of information he needed.

As a result of this visit, five keys were made from Moore's drawings and descriptions. With these the two men returned to the bank at night, let themselves in with their two keys and tried their new openers on the vault. None fitted, but by means of wax and pressure the burglars were able to determine their errors and correct them. After several subsequent visits they had their keys in proper shape and the outer doors of the vault were opened.

Moore had, of course, also learned all about the inner door on his visit to the vault agent and Hauck was provided with approximate keys to fit the two locks encountered here. Once more the process of repeated trial and error brought success and the men stood in the presence of the chest. They found that the first of its two locks merely held a guard or apron over the true keyhole. They found little difficulty in making a key to open the guard, but once they had accomplished this they met a new and apparently insuperable obstacle. The lock and key of the chest were evidently of special and exclusive design. No impression could be got and there was no hope of discovering the secret from the maker. The burglars decided that they would have to do their job at night and win their way into the chest with powder, a course they were loath to take because of its dangers. Moore had set his heart upon a mysterious noonday burglary—noiseless, swift and inexplicable. He understood that no one would notice him and his sorrel mare on the country roads in the middle of the day. No one would remark his coming or going at such an hour, whereas a flight by night from an alarmed town might be obvious indeed, especially if it ended, as was intended, at a farmhouse only a few miles away.

Accordingly, Moore went back to the bank once more to buy a few bonds, and carefully watched the cashier open the vault. The preliminaries interested him very little, but when the banker reached the chest, Moore almost leaped with excitement, for he saw the cashier reach up to a dusty high shelf and take from its hiding place the mysterious key that opened the strange lock of the money box. The burglar bought the bonds, chatted with the banker and made excuses to stay long enough to see the chest relocked and the key furtively slipped back into its niche.

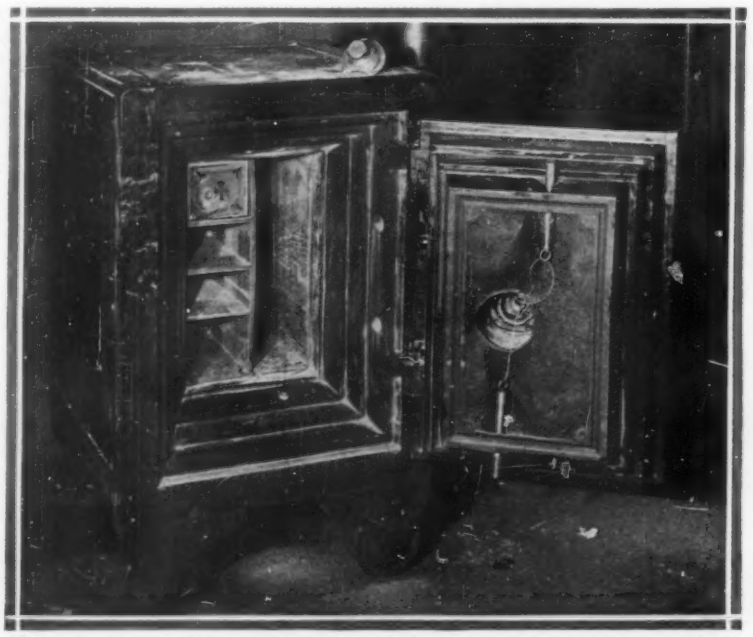
So the robbery was concluded. The plotters had nothing to do but commit it. Their preparations had taken them between five and six months, but now they were certain of their prey.

So it happened that the two men drove into Concord on that September day, just before noon, stopped the old sorrel mare at the curb opposite the bank, watched the cashier lock up and go home for his "dinner" and forthwith robbed the bank.

Hauck remained in the phæton, reading some papers which he held before his face to shield it from passers-by. Moore, armed with ten keys and a meal sack, walked across the street, opened the street door, locked it after him, ascended to the banking rooms, unlocked the door there, applied the five keys of the outer vault door in their proper sequence, opened the inner door similarly, unfastened the guard before the keyhole of the chest, took the vital key from its shelf, opened the chest and loaded the contents into his bag. He then relocked the whole defensive mechanism, taking the chest key with him, and left the building.

Hauck and Moore drove quickly back to the farm at Natick, divided and buried the loot, turned their sweaty mare loose to roll in the dust of the feedlot and were ostentatiously busy at their workaday tasks within two hours after the astounding bit of lock beating they had performed.

When the cashier returned from his luncheon and found the street door unlocked he was suspicious. When he opened the vault and found the chest key gone he was seized with alarm. Still he could not be sure there had been a robbery. Boston police were summoned and



The combination dial has been knocked off and is lying on top of the safe, but the extra bolts of the re-locker at top and bottom of the safe door went into action when the regular safe bolts were released, thus saving the contents

A safe that was attacked without success by the burglar

the president of the bank called home from Albany with the duplicate key to the chest. He could not arrive before the next morning. Then all doubt died in a flood of briny disclosure. There had been a burglary, past doubt. Three hundred and fifty thousand dollars worth of negotiable bonds were gone.

This sensational and historic incident had as much influence as any single happening upon the rapid discarding of key guarded safes in the United States and the general introduction of vaults and strong boxes equipped with spindle or combination locks, such as remain the universal safeguard today. It must, however, not be concluded that the weakness of ward or warded locks had not been understood some time before Moore and Hauck made their vigorous demonstration. Linus Yale, Jr., the inventor of the type of lock which still bears his name, had made many demonstrations of lock-picking 15 years earlier and similar feats had been performed by British lock experts, including the familiar George Price and one of the Chubbs. A lock depending on wards to prevent opening with the improper key, was shown to be easily negotiated with nothing more formidable than a bent wire; and a thousand common house-burglars on both sides of the Atlantic had used wax to make skeleton keys and open the commoner sorts of warded locks. The answer of lockmakers had, up to the time of Yale and his contemporaries, been a mere complication of the ward lock. It was more difficult to fit with keys, but nothing beyond that. Moore made the final dramatic demonstration.

Perhaps it is well to glance briefly at the historic development of the lock and the key before proceeding. Primitive devices of this kind were in use both in Mesopotamia and Egypt as early as 2000 B.C. The mysterious Biblical passage, Isaiah xxii., 22: "And the key to the house of David will I lay upon his shoulder," becomes clear enough when one sees such a key or muftah, the word used then and now in the East. The muftah is a stick of wood from 15 to 30 inches long, two to four inches broad and one to two inches thick. Into the face of one end are set a number of wooden or iron pegs, about an inch long. These pegs correspond with as many holes in the wooden bar or bolt which locks the door and can only be lifted when these pegs enter the holes and lift a corresponding series of pins, which drop home by force of gravity and keep the bar locked until pressed up by the key with its pegs. Such huge keys were carried on cords, slung over the shoulder. They opened the way into the mighty palaces of Nineveh and Persepolis and admitted to "hundred-gated Thebes."

Some authorities consider that Chinese-puzzle locks are even older, but this I question for a variety of reasons too involved for present discussion. What is true about the Chinese lock is that it was the unquestionable parent and prototype of the combination or dial lock. It opened when a secret series of characters was brought into proper juxtaposition by spinning the figured barrel or spool on its core or spindle—the same principle which governs the locks of today's great banks.

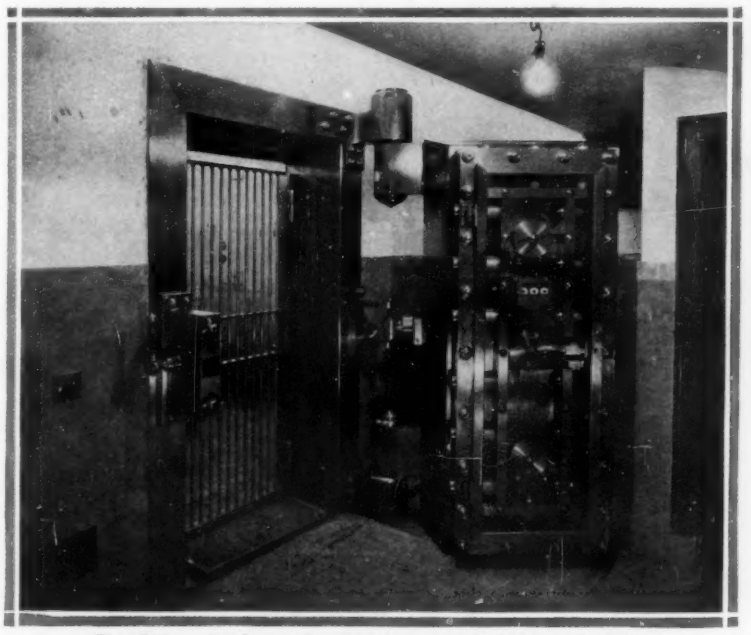
The medieval lock was a simple form of the warded type, usually opened with a heavy and marvelously wrought and decorated key. Artisans of those times, lacking the inventive imagination of later centuries, supplied great complexity and artistry instead. If their locks were not efficient they had at least the virtue of looking formidable.

One might, without too much expanding of the material, write a tome or two on the locks that have been invented and patented in modern times, even since 1850 say. The stream of applications to the patent offices of the various countries has been steady and of heavy volume. Even the various kinds of automobile locks evolved since that handy and much stolen vehicle came into the market, in the present generation, would make up a formidable procession.

Speaking broadly and without respect to accurate distinctions, modern door locks have been of only a few general varieties—ward locks, spring lever locks, tumbler locks, as first evolved by Yale, combination locks and time locks. Each type has, of course, been subjected to almost innumerable variations, complications and specializations. The point of human interest that scarcely needs stating is that all these many and ingenious developments, from the beginning of history to yesterday, owe their impelling force to the thief. The wily descendant of the cunning Autolykos has moved the imaginations of how many thousands of inventors? The charm of the situation is that he continues to whip and drive, for the unbeatable lock has not yet been designed, great though the progress has been. Even the finest and most expensive locking mechanisms of this late and towering age have been defeated or circumvented at times, and constant vigilance is necessary. The guardian lock must itself be guarded. Bankers and others having large values in money and goods in charge will be able to confirm this simple truth.

Some of this guarding of the locks has been accomplished by auxiliary mechanisms. In my recent article on the protection of great bank vaults there was set forth some of the workings of the most modern electric burglar alarms, which give a signal when any lock in a bank is opened or closed, which reveal whether the combinations have been properly mixed and set up a clamor if a wrong key is inserted into the lock of a safe deposit box. But mechanical protection of mechanisms has also been carried along another line of development and resulted in the so-called relocking devices, intended to foil the burglar who may have successfully attacked the lock mechanism of a safe or vault.

Relockers do not figure much in the calculations of urban bankers or those who make the great vaults employed in big financial houses. But to the country bank, with its necessarily frailer equipment, the relocker has become a most important aid. The rural or suburban bank has suffered for two generations from the attacks of burglars using explosives and latterly from those who employ the cutter-burner torch. Both types of bank yeggs have found it easy enough to make their way to the lockboxes of such vaults as are ordinarily employed in minor banking houses. Once arrived at the lockbox, it was no feat to pull back the bolts and open the door.



Time lock on the door and combination or spindle locks on the jamb

Another assembly that gives the cracksman a tough job

To prevent just this there came into the field a number of mechanical devices, among them the well-known dynamite trigger. This was a little arrangement of dogs or detents, actuated either by gravity or springs, which fell or were forced into place behind the inner ends of the bolts as soon as the locking mechanism was interfered with. Many ordinary office safes are equipped with such devices. Their fault has always been that the burglar who got a hole into the door of a vault or safe could readily push back the dogs or triggers with a stiff bent wire. He was, as usual, well acquainted with their location and character.

In the last few years, however, relockers of a more effective kind have come into the market and at least one of them deserves special mention. This is an arrangement of extra and entirely separate bolts, which spring into special sockets in the jamb of the safe or vault the moment an attack is made on the locking system proper. These auxiliary bolts are not only quite separate from the locking device itself and actuated by a special force, but they are situated at points on the vault or safe door as remote as possible from the original lockbox—usually the top or bottom of the door or far up and down at the jamb. (See accompanying illustrations.)

Relockers of this kind have been found effective enough in small and exposed banking houses, post-offices, offices and plants where tempting sums of money must sometimes be kept in safes or old-fashioned vaults. They are coming more and more into favor and even provide some degree of protection against the acetylene torch burglars who are gradually supplanting the old nitro yeggs. Gas bombs are now commonly used in connection with them. I have previously noted the weaknesses of and objections to the last-named protector.

Mechanical devices, such as small fences of stripped steel placed over the dial of the combination lock, are also in the very greatest banks for the purpose of guarding these locks from the prying eyes of some employee who might be loitering near when the proper officials opened the lock some disastrous morning. More than once the same numbers have been thus spied out by sharp eyes and used for larcenous purposes.

The time lock, with whose name most readers will be familiar, may itself be included among mechanical devices used to protect the main locks of vaults. A time lock, in the simplest terms, is a train of gears which are wound up and let run down in a certain predetermined number of hours or minutes. The first of them were made with only one movement. Today they are commonly made with three and often four clocks. Such mechanisms are used as auxiliaries to the combination or main lock of a fine vault. Until the clocks of the time lock have run down, it is impossible to open the vault door, even though one have the proper combination. When the vault door is properly closed at night no one can enter—unless he be a superburglar—until the movements of the time lock have run their appointed course of hours. Oppositely, even when the time lock has run down, the vault cannot be opened except by one who knows the combination. To insure the greatest safety, such vault designers as Mr. Frederick S. Holmes, to whom I am again indebted for material, now usually place the time locks on the back of the vault door and the combination lock on the door jamb. Thus a burglar would have to demolish both the door and the front wall to effect an entrance. When one considers that the wall of a vault into which the door fits—the vestibule wall—is often more than four feet thick and that the spindle of this lock must reach through this wall, from the dial to the back of the disks, the impressiveness of the device appears. Such a lock spindle is often five feet long.

Having made the general observation that all kinds of locks have been beaten by burglars, occasionally at least, we come to the old question of the possibility of defeating the dial or combination lock without the use of explosives or destructive agents of any kind. There has always been argument on this point. There have in the past been devised many fictions on the subject. The whole question wears the fabulous habiliments of romance. To recount only the most celebrated instance of fictive meandering, we must go back to O. Henry and to Paul Armstrong, who dramatized the former's "A Retrieved Reformation," into the play "Alias Jimmy Valentine." Henry, who should have known better, permitted his hero to open the vault of a city bank in a few minutes with a marvelous set of burglar's tools, such as never were on land or sea. In making the dramatization, Armstrong went him one better. His hero sensitized the tips of his fingers by rubbing them excruciatingly over a sheet of sandpaper and then "felt" the combination open, releasing the imprisoned and slowly stifling heroine.

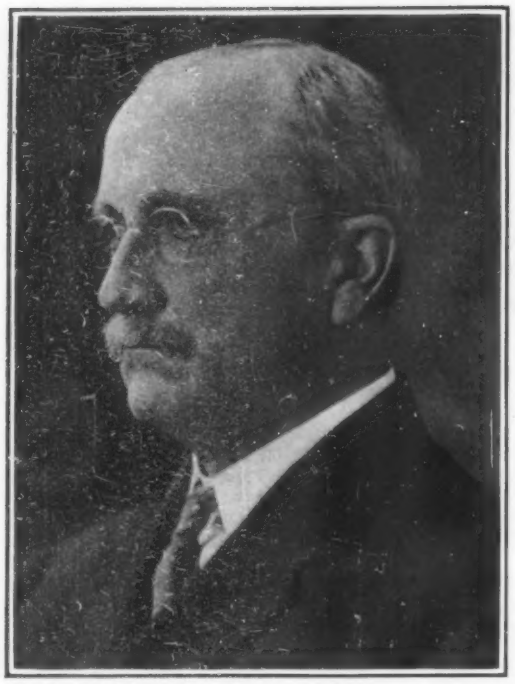
Safemakers laughed. Burglars chortled with amused incredulity—many of them, all I ever talked with on the subject. I myself, being summoned for an opinion, dismissed the idea with too much scorn, it appears. For half a dozen years the question kept bobbing up from time to time, and though I inquired far and wide among all who might have been expected to possess special knowledge on the point, no one appeared who had the least confidence in the notion.

Then came the sudden and dramatic apparition of Mr. James Biancolo, up to that moment an obscure safe repairer and dealer in lower New York. The district attorney had seized the office safes of Brindell, the convicted labor organizer, and wished to get at the contents before the trial for what evidence of crime

(*Continued on page 142*)

Power from Mercury Vapor

Astonishing Fuel Economy Brought About Through Ingenious Combination of Mercury Vapor and Steam



W. L. R. Emmet, designer of the mercury-vapor boiler and engine

THERE is now running, as part of the equipment of the Hartford Electric Light Company, a combined mercury-vapor-and-steam plant, which is showing a truly astonishing fuel economy, and in spite of its extreme novelty, is operating with all the regularity of a standard steam plant.

It has been recognized for long past that there was promise of great economy in the production of mechanical power, if a way could be found to utilize the vapor of two different fluids, each having its own characteristics of vaporization. Many of our readers will remember the experiments made at the well-known Charlottenberg Technical School at Berlin with an engine built on the binary fluid system, in which mechanical power was secured by the joint action of steam and the vapor of a highly volatile liquid.

Among the most promising combinations, theoretically, was in the combined use of mercury vapor and steam; but nothing was ever done in this direction, so far as we are aware, until Mr. W. L. R. Emmet began, about twelve years ago, a deep study of this subject, during the course of which the General Electric Company built for him at Schenectady an experimental mercury boiler and mercury-vapor turbine. This apparatus gave sufficiently promising results to warrant the construction of a second installation, and accordingly they built the present mercury and steam plant, which is of no less than 6000 horsepower. It has been erected at the Hartford Electric Light station, where it is now being operated as part of plant.

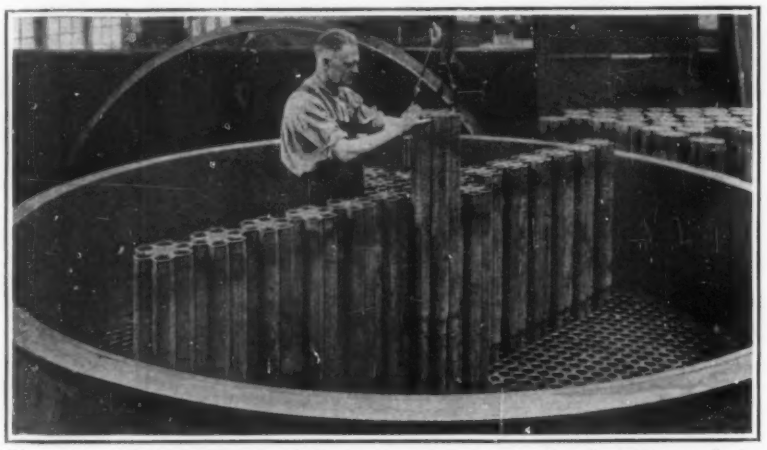
The inventor is well known to our readers as one of that brilliant group of men which the General Electric has gathered at the laboratory of the Schenectady plant. He was responsible for the development of the Curtis Turbine, and the promotion and direction of the company's steam turbine activities for many years. He is also the originator of electric ship propulsion, and has promoted and very largely designed the applications of this system which have been made in the United States Navy and elsewhere.

Mr. Emmet estimated that if the mercury boiler came up to all expectations, when compared with a steam turbine generating plant which uses 200-pounds steam pressure, it would produce with 35-pounds gage pressure about 52 per cent more output in electricity per pound of fuel. These results are now being realized in the plant at Hartford. "And if," Mr. Emmet adds, "in such a plant the steam boiler room were re-equipped with furnaces and mercury apparatus arranged to burn 18 per cent more fuel, the station capacity with the same steam turbines, condensers, auxiliaries, water circulation, etc., would be increased about 80 per cent."

The process is novel in every particular, and it was necessary, at the outset of the investigation, to make an elaborate study of the characteristics of mercury and its vapor. During the earlier experiments it was found that no form of packing of the joints would resist the mercury vapor; and were it not for the development of arc and acetylene welding, the construction of the boiler and its connections would have presented a most difficult, if not insoluble problem.

It was necessary for the inventor not only to design entirely new apparatus but also to devise methods of operation. Since there was no past experience to draw upon Mr. Emmet had to design, from the ground up, an entirely novel plant; which was built at Schenectady, shipped to Hartford, erected and started, and has been successfully operated, exactly as designed, for several consecutive months.

The mercury vapor process involves the vaporization of mercury in a boiler, driving a turbine by the mercury vapor, and the condensation of the exhaust in a condenser where its latent heat is delivered to water and thus used to generate steam at a pressure suitable for use in the existing steam plant. The condensed mercury runs back by gravity into the mercury boiler. Thus the mercury vapor acts as a heat conveyor and, at the same time, delivers energy to the mercury turbine. This affords a means by which the temperature range of operation is more than doubled as compared with ordinary steam processes, and the efficiency consequently greatly increased. Means are also provided by which the flue gases are brought to temperatures equivalent to those used in steam plants, by being carried through a mercury feed heater, a steam superheater, and a feed-water heater. Mercury boils and condenses much like water, except that its density is much greater and its boiling temperature much higher. At atmospheric pressure mercury boils at 677 degrees Fahrenheit and water at 212 degrees. Mercury condenses in a 28-inch vacuum at 455 degrees Fahrenheit and water at 100 degrees. The great economy of the Hartford unit is due to the high boiling-point of mercury and the relatively large amount of heat that is stored in the vapor.



The tubing of the boiler, in which mercury vapor is produced at 35 pounds to the inch pressure, for operating a single-wheel turbine

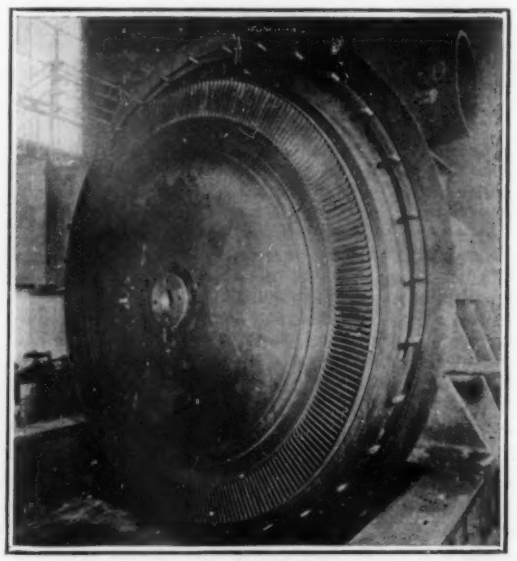
The mercury boiler plant, as erected at the Hartford station, is housed in a two-story steel and brick building, which is about 25 feet square and 40 to 50 feet in height. On the ground floor are the mercury boiler, mercury heater, steam superheater, and feed-water heater; on the floor above are the combined mercury-vapor condenser and steam boiler, and the mercury-vapor turbine, which is direct-connected to a 1800-kilowatt generator. At present the steam generated by the condensation of the mercury is led directly to the main steam line of the plant. Ultimately it will be possible to utilize this steam in a steam turbine, the supply of steam at 200-pounds pressure being sufficient to drive a 2200-kilowatt generator.

The accompanying photographs represent certain parts of this installation; and in our wash drawing, which is schematic in character, the various elements have been rearranged so as to render the plan more intelligible to the lay reader. Hence, we show the steam being led directly to a steam turbine, which is direct-connected to a 2200-kilowatt generator.

The mercury boiler, shown at "B," consists of a nest of hexagonal tubes carried at the top of a circular firebrick furnace, "A," which is provided with three oil-fuel burners "a." These tubes are arranged in groups of seven, of which the center tube has a single wall and serves for the down-flow of the mercury, and the six tubes grouped around it are double walled and serve for the up-flow of the mercury through the annular spaces. The base of the down-flow tubes is provided with a slot which permits the mercury to return through the circular honeycomb system thus formed. It will be noted that the arrangement is similar to that of the radiator of an automobile, and its object is to secure a very large evaporating surface. The mercury commences to boil at 677 degrees Fahrenheit, and the vapor is led at 35-pounds pressure to a mercury-vapor, single-stage turbine "G," where it condenses in a 28-inch vacuum at a temperature of 455 degrees. The condensation takes places amid a nest of tubes carried at the mid-height of the condenser "H." These tubes are filled with water, which boils under the great heat of the mercury vapor and generates steam which collects in the steam drum above at a pressure of 200 pounds to the square inch. The condensed mercury falls to the bottom of the condenser, from which it flows by gravity through the pipe "J" to the bottom of a mercury heater "C." This heater consists of a nest of vertical tubes, and as the hot gases from the mercury furnace pass up around the tubes, they preheat the mercury, which returns to the mercury boiler "B," thus completing the cycle.

Although in our diagram the steam from boiler "H" is shown as being led directly to the steam turbine which runs the generator "L," in the Hartford unit it is first led through the nest of tubes of a superheater "D" where the furnace gases give up more of their heat. From the steam superheater, the hot gases are led down through a feed-water heater "E." Finally at "N" they pass to the smoke-stack at about the same temperature as the gases from a standard steam plant.

We have already stated that, because of the extreme novelty of this invention, Mr. Emmet was obliged to do his work from the ground up. Very little was known about the action of mercury, under the proposed conditions of high temperature necessitated in the proposed boiler and engine. There was the serious problem of making mercury-tight joints in the boiler, the piping and the turbine; for mercury fumes are highly poisonous. The use of packed joints was out of the question. Hence, it was determined that the only satisfactory method of sealing the joints was to weld them. A few years ago this would have been impossible, but thanks to the



Special design of wheel for the mercury turbine

development of oxy-acetylene and electric welding, it was possible to produce gas-tight welded joints throughout the whole of the plant, and this has been done with highly satisfactory results.

Another problem was that of providing for expansion in the piping; and this was done by using annular steel discs welded at their outer and inner edges, thus forming an accordeon-like construction which provided for free longitudinal movement. This device is operating successfully.

When the reciprocating engine had been fully developed, the first notable advance in economy was the replacement several years ago of the reciprocating engine by Parsons' epoch-making invention, the steam turbine.

The modern steam turbine, under similar conditions, is about 40 per cent more efficient than the best reciprocating engine, and the attainment of this degree of gain has been the work of twenty years. "It would seem," Mr. Emmet says, "that the introduction of the mercury process would accomplish an even greater gain." The change from reciprocating engines to steam turbines necessitated complete redesign of the old stations. But, in applying the mercury process, it is only necessary to replace the steam boiler in the large modern plants by a mercury boiler which will give greatly increased output in the same space. In other words, there will be no general redesign of a station to obtain the benefit of the better economy and at the same time materially increase the output from the building. As in all great steps in advance, time will be required to develop and perfect this system before it can be expected to reflect on the operating costs of the public utilities as a whole.

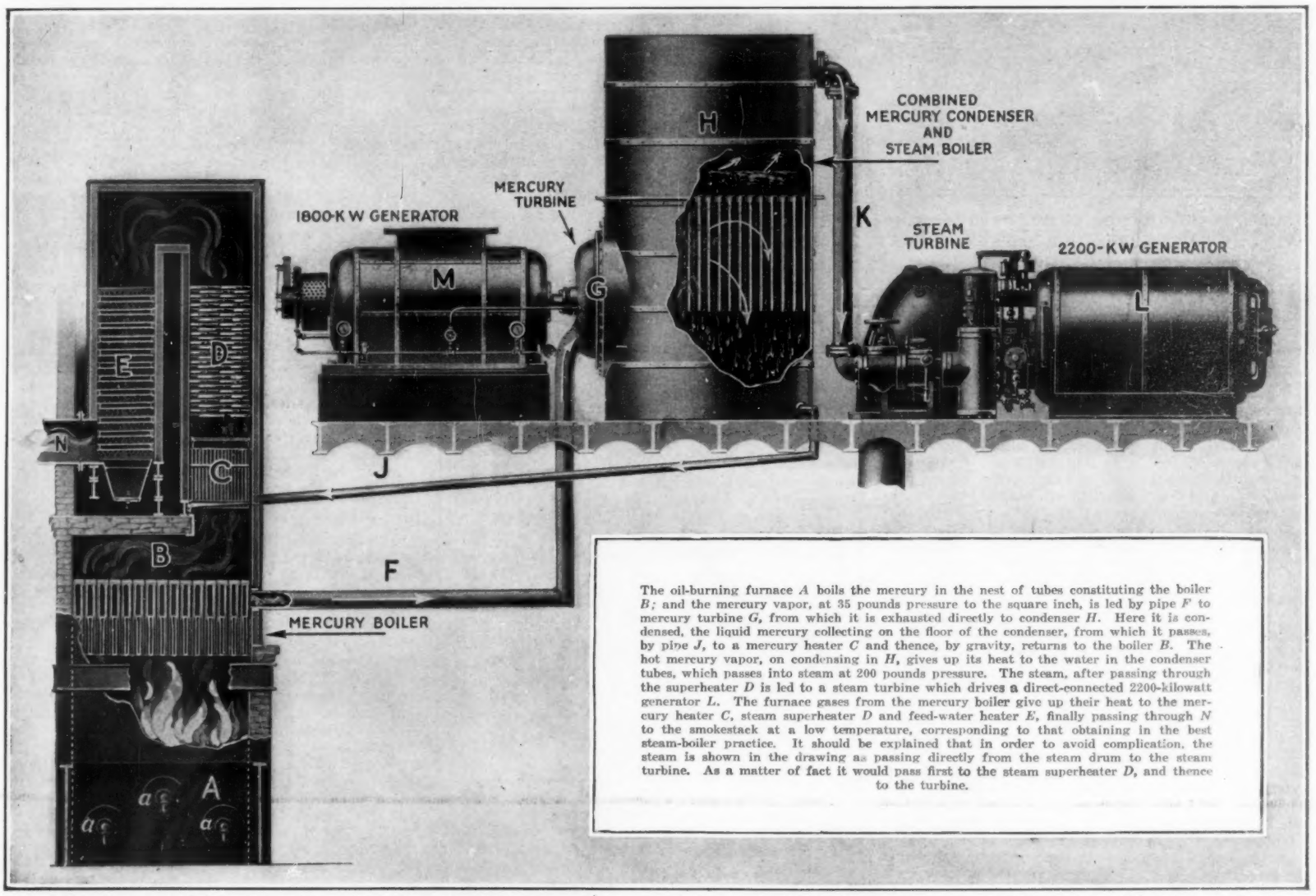
Naturally the question will arise as to whether the new process involves danger from mercurial poisoning, either to the community or to the attendants. In the first place, as previously stated, all joints are welded, so that it is impossible for mercury to escape except through accident, and in the second place arrangements are such that leakage, if it should occur, will be carried into the stack where it can do no harm.

At present mercury sells for about 80 cents a pound. The boiler installed in Hartford contains 30,000 pounds of mercury, and is designed to give from mercury and steam about 4100 kilowatts, or say to about 7.3 pounds of mercury per kilowatt. Recent experiments indicate that in future design four pounds per kilowatt will be sufficient.

During our visit to the plant, Mr. Ferguson, President of the Hartford Electric Light Company expressed himself as greatly impressed with the performance of the new unit and went on to say:

"Large as is the item of fuel in the cost of making electricity, it is only one item, and the fact that electric power companies can look forward to making their coal go twice as far does not mean that electric light rates can be cut in half. We figure the cost of current in Hartford at three cents a kilowatt, and of this fuel represents only eight mills. The rest of it is represented by labor costs and the heavy overhead necessary for an electric power company to be in readiness 24 hours a day to furnish power and light, whether it is called for or not.

"But as the mercury boiler comes into general use and is perfected, we have every reason to hope that it will bring a saving in the power bill to the consumer, for reasons of our own prosperity as well as that of the consumer. With coal and transportation as expensive as they now are, the manufacturers of the Eastern seaboard states are at a distinct disadvantage compared to those further west where coal is nearer, tending to draw manufacturers away from this field. A lowering of the rates here would aid both the public utilities companies and the population generally."



The oil-burning furnace *A* boils the mercury in the nest of tubes constituting the boiler *B;* and the mercury vapor, at 35 pounds pressure to the square inch, is led by pipe *F* to mercury turbine *G*, from which it is exhausted directly to condenser *H*. Here it is condensed, the liquid mercury collecting on the floor of the condenser, from which it passes, by pipe *J*, to a mercury heater *C* and thence, by gravity, returns to the boiler *B*. The hot mercury vapor, on condensing in *H*, gives up its heat to the water in the condenser tubes, which passes into steam at 200 pounds pressure. The steam, after passing through the superheater *D* is led to a steam turbine which drives a direct-connected 2200-kilowatt generator *L*. The furnace gases from the mercury boiler give up their heat to the mercury heater *C*, steam superheater *D* and feed-water heater *E*, finally passing through *N* to the smokestack at a low temperature, corresponding to that obtaining in the best steam-boiler practice. It should be explained that in order to avoid complication, the steam is shown in the drawing as passing directly from the steam drum to the steam turbine. As a matter of fact it would pass first to the steam superheater *D*, and thence to the turbine.

Schematic view arranged to show the various elements of the mercury-vapor and steam unit of 6000 horsepower, now operating as part of the plant of the Hartford Electric Light Company

Extinguishing Ignited Gas Mains

IN large cities where electric cables, gas mains and sewers are huddled together underground, the gas mains sometimes become ignited due to leakage, short circuits in the electric cables and similar causes. This condition usually takes place in one or more adjacent manholes.

Recently a large gas main serving thousands of gas users was ruptured and at the same time a short circuit occurred in a high-voltage cable. The explosion broke open the main, the ignited gas roaring up some 35 feet into the air. The heat was so intense that neither firemen nor gas repair men were able to reach within many feet of the flame. The broken pipe was fed with gas from both ends. It was considered inadvisable to shut off the gas at the gas house because the lives of many hundreds of gas users would be endangered should their gas burners be turned on when service was renewed after repairs.

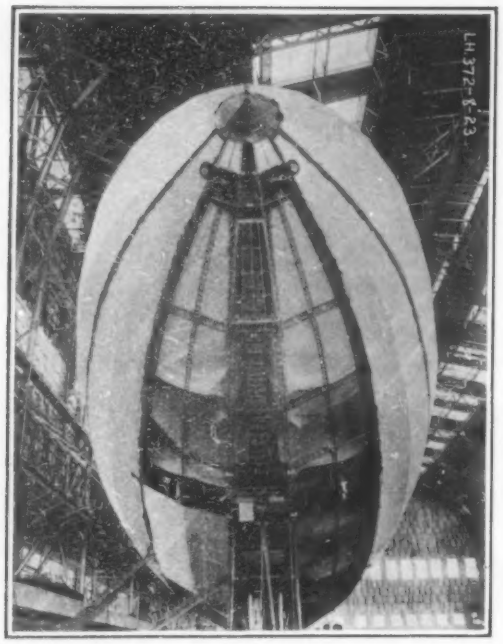
After the fire had roared for considerable time, a very interesting method of snuffing it out was adopted. Holes were dug in the street, one on each side of the fire; and as close to it as was feasible. When the large gas main was exposed at both places, men were put to work to drill a hole about 1½ inch in diameter in the pipe at each place. Both holes were completed at about the same time, as each gang was synchronized with the other.

As soon as both holes were completed, a leather bag very much like a child's toy balloon only folded up to look more like a cartridge, was inserted into each hold in the gas main. Once inserted in the gas main, an air pump was connected to each bag and the bags pumped up to a pressure of more than 80 pounds. As the bags or balloons filled with air they became bigger and conformed to the shape of the main. The bigger they became the more they restricted the flow of gas until finally the gas was shut off entirely and the fire was snuffed out.

This method of "snuffling out" an ignited gas main is safe; it does not endanger people connected to an extensive network of pipes and minimizes the interruption of service by affecting only the section of gas main involved.

Our First Rigid Airship the "Shenandoah"

The Design, Construction and Successful Trials of the Great Airship Built by the United States Navy



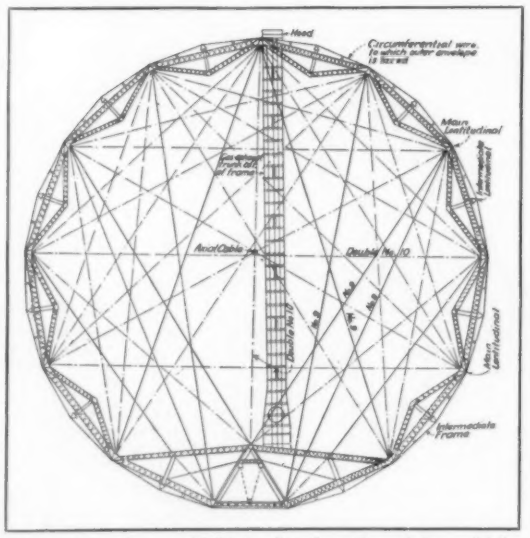
Placing the outer covering on the bow of "Shenandoah." Note the netting against which the gas bags bear

IT WILL be admitted that credit is due the United States Navy for its courage in carrying through the construction of a Zeppelin type of airship, at a time when faith in these fragile constructions had been rudely shaken by the tragic loss, with British and American officers aboard, of a similar type of ship, built in England for the United States Navy. The type was further discredited when the British Government discarded its airship fleet altogether, and offered it to any private interests that would take over its ships and operate them commercially. Our Navy Department, realizing that nothing had happened to prove that the theory of the airship was at fault, was not discouraged by this accident and the subsequent action of the British Government. The Department believed that, profiting by the experience and accumulated technical data of the past, and by careful work in the designing office and in the testing room, it would be possible to build an airship of the largest size that would stand up to its work, endure any of the stresses to which it would be exposed in service, and would provide the Navy with a most important addition to its scouting forces. That the Department was not over-optimistic has been proved by the consistent performance of our first rigid airship, and the facility with which it has been handled in a series of long distance trips that were made during the latter part of 1923.

The "Shenandoah" was designed by Commander J. C. Hunsaker of the Construction Corps of the United States Navy. The design of the details, the building of the various parts of the structure, and the installation of the power plant, were done under the direction of Commander G. C. Westervelt of the Construction Corps of the Navy, at the Naval Aircraft Factory, Navy Yard, Philadelphia. The erection of the ship took place in the large hangar at Lakehurst, New Jersey, under Commander R. D. Weyerbacher, also of the Construction Corps of the Navy.

The ship is of the usual cigar-shape form with a circular cross-section. She is 680 feet long, and 79 feet it. diameter at her mid-section. The frame is built up of circular rings, spaced 32 feet 9 inches apart and rigidly tied together by 13 longitudinals, and the whole frame, as thus built up, is maintained in its true form by an elaborate system of wire diagonal bracing in the plane of each ring and in the planes of the rectangular panels formed by the intersection of the circular frame members and the longitudinal members. The above constitutes the main structural frame upon which the rigidity of the ship as a unit depends. But half way between the main frames are other frames of lighter section which are not provided with wire bracing; also intermediate with the main longitudinals are others of a lighter section. The panels formed by these intermediates and the main longitudinals are also braced by secondary wire diagonals at the outer surface. There are 13 of these main longitudinals and 12 of the intermediate or secondary longitudinals, and hence the surface of the finished ship, when covered with fabric, presents the form of a polygon of 25 sides. The entire frame, as thus assembled, consists of duralumin struts and girders and wire tension members. Its weight, in spite of the vast size of the structure, is only 15 tons and there are no less than 3000 struts, big and little, employed.

Duralumin was developed for airplane and airship construction. It is a remarkable metal; for although its specific gravity is only a little over one-third that of steel, it has an elastic limit of around 35,000 pounds and an ultimate breaking strength of 55,000 pounds. The girders and struts are all triangular sections, and they are built up of rolled longitudinal members, latticed together with special-form, sheet-duralumin lattice pieces. As we have said, the fabrication of the parts was done at the League Island shops, where everything was built and the holes were drilled, preparatory to rivetting the frame at the Lakehurst hangar. The assembly and rivetting up of the smaller parts was done at the Naval Aircraft Factory, and the final assembly of the frame itself was done at Lakehurst. The great ring frames were assembled in a floor jig in a horizontal position and rivetted, the wiring which holds the ring to shape being inserted and given the necessary tension to bring the ring to true form and hold it rigidly. The assembly of the frame was started at the center of the length of the ship; the longitudinals were rivetted in place and the diagonal wires inserted and drawn up, until everything was in proper alinement and the wires given their proper tension. The



A cross-section amidships, showing the wiring which holds the circular frame to true form

work was carried on in equal portions toward the opposite ends, until the job was complete. Due to the careful preparatory work at the factory, everything went together with great exactitude and the frame when finished was exactly true to its designed shape.

The wiring consists of hard-drawn steel wire of from 9 to 11 gage; 12 and 13 gage being used in some of the smaller work. Instead of turnbuckles, the tension in the wires was secured by the use of end loops and a special tensioning device. The maximum tension used was 300 pounds.

From our description, it will be seen that the main frames divide the ship longitudinally into sections which are 32 feet 9 inches wide by the full diameter, 79 feet, of the ship.

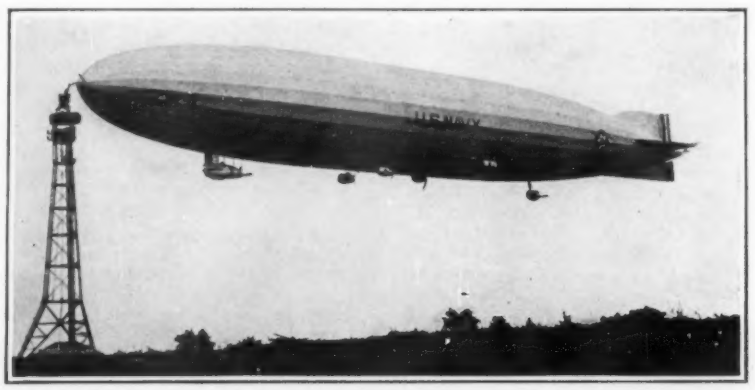
Each of these spaces is occupied by its own gas bag which is made of goldbeater's skin, a light, strong material which is impervious to gas. At the top of the bag is an escape valve operated by hand, through a light cable leading to the control car, and at the bottom is an automatic release valve, which vents upwardly to the top of the ship through a tube which passes between the bags. The inner surface of each frame is covered with a network of No. 13 wire which is fastened to the channels of the longitudinal members and to the ring frames. The spaces in the wire mesh measure about 18 inches, and inside this mesh is another netting of cord with a nine-inch mesh. The outward pressure of the gas in the bag is transmitted through this netting to the frame of the ship. The outside of the "Shenandoah" is covered with a skin of rubberized fabric, which is laid on in wide longitudinal strips that are laced around the edges of the frame members. The longitudinal seams of this covering are closed with other strips which are cemented on. After the covering was completed the whole surface was coated with cellulose acetate.

As will be seen from our cross-sectional view of the ship taken amidships, the lowest member of the outside of the ring is shorter than the others, and from its ends there rise two inclined members which meet and form a closed triangle. From the apex of this frame, two girders extend to the sides of the ship and are connected to the nearest panel points of the main frame. These triangular frames are erected upon the ring frames and are connected together by longitudinal girders, the whole forming a stiff triangular construction extending throughout the length of the ship. A short distance below the apex of the system, the side legs are connected by small transverse girders, and upon the platform thus provided, at certain selected locations, are carried the fuel tanks, which are hung in groups along the length of this keel. Water ballast tanks containing one ton of water each are placed in the same structure. The pull of the propellers is applied to the frame at the frame panel points to which the power cars are attached. The pull is also transmitted by wiring carried from the motor cars to the frame.

The fuel is contained in 40 tanks, each holding 113 gallons, making a total load of 4520 gallons. If it were desired to fuel up for a lengthy non-stop trip, it would be possible to install 78 tanks holding a total of 8834 gallons.

It will be realized from the above description, that the concentrated static loads of the fuel, and of the engines and the propulsive force of the latter, are concentrated at certain definite locations along the 680-foot length of the ship. The heavy stresses resulting from the action of the fins and the vertical and horizontal rudder, act immediately on the after or tail section of the frame.

Now it will be understood that the determination of these localized stresses, and the way in which they distribute themselves throughout the whole frame of the ship, called for some very careful designing; and, with a view to checking up the calculations of the naval constructors, an engineering board, composed of men outside of the Navy, was appointed by the Navy Department to make an independent investigation of the design. It is gratifying to know that this board has endorsed the design as being fully adequate and reli-



"Shenandoah" moored to her steel mooring mast, 167 feet in height. She is maintained on a level keel by discharging gas if she rises, and water if she falls

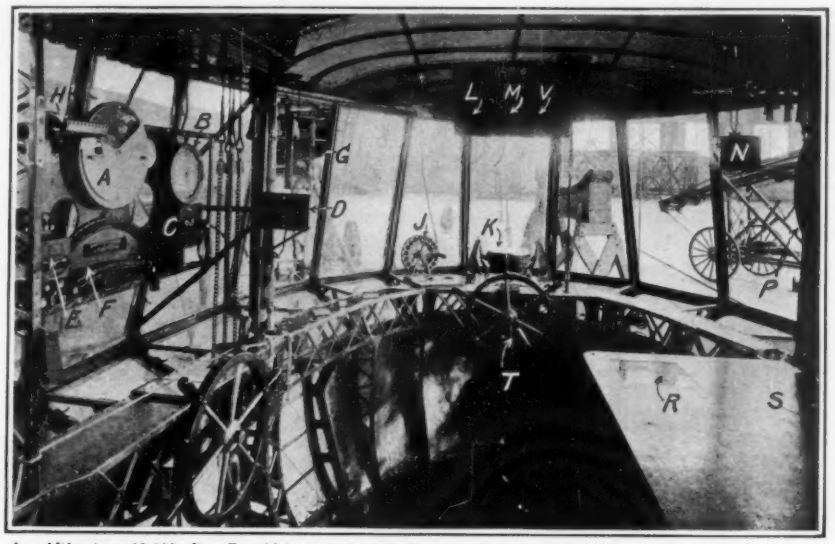
able. Tests were made in the hangar with the gas bags completely filled, by applying loads at selected positions along the keel, and recording the effects on the frame. Then the loads were moored to other positions and the stresses noted. Also local tests were made on various parts of the structure. The reading of the stresses was done by the McCollum-Peters carbon-resistance strain gages of the Bureau of Standards. These "shop tests" have been supplemented by strain-gage tests taken during the various flights of the "Shenandoah" during the past autumn. Although the maximum working stress, as calculated, was 9000 pounds per square inch, the strain-gage reading shows that the maximum stress when the ship was in flight was 8000 pounds per square inch.

In designing the "Shenandoah," many minor factors were sacrificed to safety and reliability. In other words, the "Shenandoah," relatively to previous airships, is of unusually strong construction. From the data secured in active service our naval constructors will be in a position to develop a ship which will be faster; will possess a larger radius of action; will be lighter; will carry a bigger load, and at the same time will be safe and reliable. The weight of the "Shenandoah" at present is 33 tons, of which the useful lift is between 12 and 13 tons. Her maximum speed is about 65 miles per hour.

In a recent article describing the flight of the "Shenandoah" over New York City, the writer dwelt upon the beauty of the ship and the perfect control which was evident in her various maneuvers. To give an adequate impression of the majesty of such a great airship as this one must view it at close range, and this can best be done by a visit to the great hangar in which she is housed at Lakehurst, New Jersey. The hangar, which was built some three years ago, towers in the center of a level plain which has been cleared for the purpose in the forests of New Jersey. Here everything is on the grand scale. The hangar measures 952 feet over all and 348 feet wide, and has a total height to the top of the roof of 201 feet. The inside dimensions are 803½ feet by 258 feet with a clear height of 172 feet, and within this vast space there is an abundance of room to house, side by side, two dirigibles of far greater size than the "Shenandoah," and still have all the room needed to handle them. Running the full length of the hangar is a series of steel tracks, which extend far out into the field ahead. These are provided with electric trolleys to which the ship can be attached by cables and thereby be securely drawn into the hangar. The building is closed by two vast sliding doors each of which weighs 1300 tons. They withdraw transversely upon steel tracks and are operated by electric motors.

By the courtesy of Captain McCrary, who is in command at Lakehurst, the writer made a thorough inspection of the pilot car, from which the ship is navigated, and of the interior of the ship itself. Our colored cover and one of the accompanying photographs show the interior of this car looking forward. In common with all the motor cars, it is built of aluminum, and around the front and sides are large windows affording a wide range of vision. The car is about 20 feet long with a clear inside height of about 8½ feet. The lettered photograph with its caption will make clear the position of the various instruments and their use. The navigation of the "Shenandoah" is in many respects similar to that of sea navigation. She is steered in a horizontal plane by the wheel at the front, and in a vertical plane by the wheel shown to the left. The pilot in front has a compass before him, and in front of the wheel controlling the elevation are two inclinometers. To the right is a chart table with a five-inch compass recessed below the board. There are instruments for showing the speed of the ship, a telegraph dial for engine control, a barograph, altimeters, and a gas-pressure indicator. To the left near the ceiling are the terminals of wire ropes leading to the valves for venting the gas when it is necessary.

"Shenandoah" is driven by six 6-cylinder engines, contained in six separate cars, of which the pilot car is the largest. The engines are identical and each can develop 300 horsepower at 3000 feet. The pilot car is hung below the center of the ship forward. Abaft of this are two wing cars, each with its own engine, and abaft of these and about 35 feet out from the center line of the ship are two other wing cars, while astern on the center line is the sixth car. The cars of the forward pair are placed about 40 feet apart, and those of the second pair about 70 feet apart. This staggered arrangement serves to distribute the stresses and avoid interferences by the wash from the propellers.

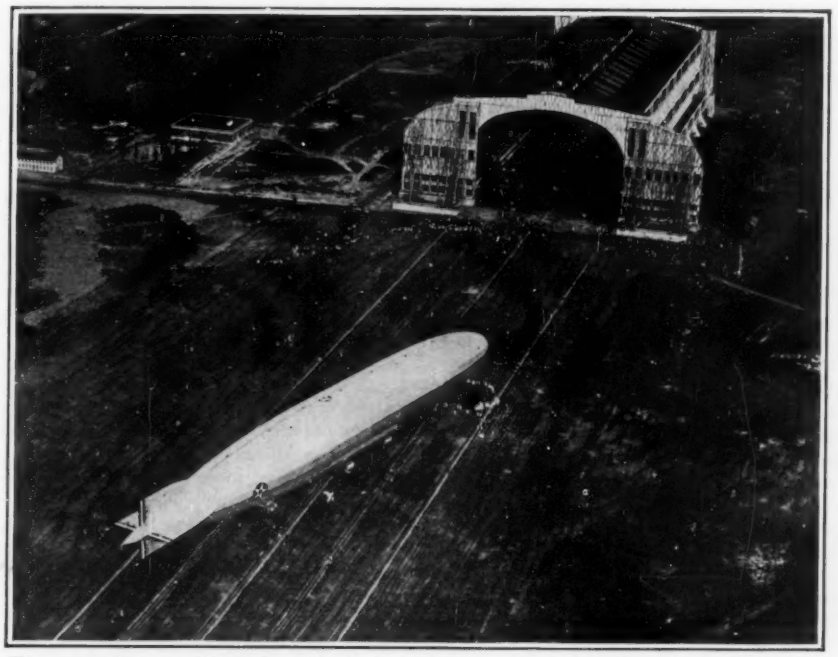


A: Altimeter, 12,000 ft. B: Altimeter, 30,000 ft. C: Gas pressure alarm. D: Pitch indicator. E: Gas temperature thermometer. F: Inclinometers, 45°, 15°, 10°, with elevator control-wheel below. G: Variometer. H: Bracket for barograph. J: Air speed "Reel." K: Compass, 7½ inches. L: Air speed indicator. M: Turn indicator. N: Variometer. P: Engine control—telegraph dial. R: Compass 5 inches below chart table. S: Chart table. T: Steering wheel controlling rudder. V: Air-speed indicator

The control car from which "Shenandoah" is navigated

Climbing up a vertical ladder from the pilot car, one reaches the inside of the ship, landing upon a light 10-inch plank footway which runs the whole length above the keel. Step off this platform or slip from it, and if one were not so fortunate as to land upon some member of the widely spaced frame, he would keep going until he reached mother earth: for there is nothing to stop him but the thin rubberized fabric of the outer covering. Hence, the writer felt considerable respect for the crew who are sufficiently expert to climb into and out of, and sleep for their "four hours off," in a hammock swung between two uprights, with nothing between them and the ground but a thin piece of silk and several thousand feet of the atmosphere. Walking down the gangway one sees the framework of the keel below and the vast arms of the circular frames curving around to meet 70 feet above his head. Only the lower third of this framework is visible, the overhead view being obstructed by the bottom of the gas bags with which the interior is filled.

About the middle of the ship one finds the crew's quarters, so called, for at the time of the writer's visit they were purely of a temporary nature. Outside of the hammock and a bench or two of light construction there was little in the way of accommodation to be seen. It is intended, however, to devise and fit bunks of very light construction and make other provisions for comfort during extended cruises. The control of the altitude of the ship is secured by adjusting the quantity of gas in the bags to the total weight. As the fuel is consumed, and the weight decreased, gas must be vented or the ship will rise. Similarly when a descent is to be made to the ground, gas must be vented again. The control of the gas bag is associated with the control of the elevators, and by this joint means it is possible to hold the ship at any desired elevation. The "Shenandoah" carries a crew of 22. There are nine officers, including the Commanding Officer, Captain McCrary, the Executive Officer, the Navigation Officer, three Watch Officers, the Chief Engineer and his assistant, and a Radio Officer.



The ground crew guiding the ship into the hangar after her return from St. Louis

The Auxiliary Language

WE hear much about the desirability of selecting an auxiliary or synthetic language for international use in science, technology, commerce, radio-communication, etc. Such a language will never be selected or determined, even by authority, if we use those words in an arbitrary sense. It will, rather, be discovered, that is, it will be dug out of the linguistic mines of the Occidental world. This procedure was, seemingly, followed by a group of linguists and specialists who met in Paris in 1907. They put the root-words of numerous ideas upon the wall, as it were, in parallel columns, in English, French, Spanish, Italian, German, Dutch, etc., and then struck the greatest common divisor, so to speak. Thus they arrived at maximum internationality and consequent naturalness, but governed always by strict regularity and facility. Their fundamental principle was enunciated by Professor Otto Jespersen, a well-known philologist of Copenhagen, who said: "That international language is best which is easiest for the greatest number of men." ("Ta internaciona linguo esas la maxim bona qua esas maxim facila por la maxim granda nombro di homi.") The development of the language, which is known as Ido (pronounced ee-doh), has been carried on, in like manner, by other committees, some of which are still engaged in the task. Every root-word, or element chosen, is voted upon by the members of the committee in various parts of the world. Such active collaboration is just what is needed to insure the requisite neutrality, accuracy and expressiveness. The resultant language, which is very flexible, is phonetic and euphonious. It sounds something like Spanish or Italian. Being free from any exceptions or irregularities, it is obviously easy to learn. It is, indeed, understandable almost at first sight, particularly by any one having the least knowledge of any Romance language. Translations from difficult works by Henri Bergson and Einstein have, it is said, been successfully carried out, thus showing the ability of the language to respond to intricate thought. In spite of its simplicity, the language is said to be so perfectly logical that it is free from all ambiguity. Next we may hear of American radio amateurs communicating in a common tongue, by wireless, across the Atlantic, with radio fans in France, Belgium, Holland, Denmark, Switzerland, etc.

Our Point of View

The Two-Fluid Engine

IT is acknowledged that the great turbo-electric power stations of the country have carried the development of the steam engine to a higher level of economy than has been anywhere attained, at least on a large commercial scale. The modern steam turbine, as employed in the big power stations, is said by Dr. Emmet of the General Electric Company to be 40 per cent more efficient than the best reciprocating engines. This is accepted as the high-water mark of present steam-engine practice.

In view of the excellence of this performance, it must be admitted that the results which have been attained at the Hartford Electric Light Company, with a combined mercury-vapor and steam unit which they have recently incorporated as part of their turbo-electric plant, are very startling. It is officially announced that, as the result of several months' operation, the coal bill so far as this unit is concerned has been reduced by 52 per cent. This economy is attributed to the high temperature at which mercury boils and the correspondingly large amount of heat which is available, first for the operation of a mercury-vapor turbine, and then for the operation, by the exhaust from this turbine, of a complete steam turbine unit. Not only does the mercury vapor serve to operate an 1800-kilowatt generator, but there is sufficient heat left in the exhaust for the operation of a steam-driven 2200-kilowatt generator.

How far the new system can be applied to the existing power stations of the world can only be conjectured. If the unit at Hartford continues to show the remarkable economy which has so far been recorded, it is only a question of time when there will be a demand for its wider use. This raises the question of the supply of mercury, and, in this connection, Dr. Emmet reminds us that since, by the adoption of electric welding he has succeeded in making his boiler and turbine perfectly vapor-tight, there can be no loss of mercury, and a plant once supplied with its quota will require practically no replenishment.

It would seem, furthermore, that, by the substitution of electric welding for packed joints, the danger of mercurial poisoning has also been eliminated. It is safe to say that the users of power the world over will watch the further development of this apparently epoch-making invention with the very closest attention.

In conclusion, it must be remembered that, in spite of the positive results thus far obtained, both the General Electric Company and its inventor consider that the Hartford unit is still somewhat in the experimental stage. They predict that, with the use of higher pressures and a mercury turbine of improved design, it will be possible to obtain even better results with a smaller charge of mercury.

Oil Fuel as a Life Saver

THE primary advantages of oil firing on ships—its cleanliness, saving of bunker space, and the great reduction in the fireroom force, are well understood; but besides these there are many other advantages of a minor character, which in the aggregate are of no little importance. This fact was brought out in a lecture recently delivered in London before the Institution of Mechanical Engineers, by Sir Westcott Abell, when, in speaking of the question of hull sub-division, he pointed out that in an oil-burning ship or a motor ship, the inner walls of the oil-bunkers, extending parallel with the side of the ship and, say, about fifteen feet from the side, actually form an inner skin below the waterline. Not only so, but the space thus formed, which extends for a considerable length of the vessel amidships, is sub-divided by transverse bulkheads spaced about twenty feet apart longitudinally. Obviously, since all this work must necessarily be made watertight, the safety of the ship is materially increased.

Another advantage is related to the provision of openings from boiler room to boiler room, which have to be made in the transverse bulkheads of the ship to allow of communication. In the oil-driven ship these openings can be made comparatively high up in the bulkheads, whereas in coal-fired ships they must be down level with the boiler room floor. In some coal-burning ships, it is true, in which special attention has been given to safety, the bulkhead openings have been placed above the waterline; but such cases have been rare. Watertight doors, moreover, whether they are operated by hand or by power, are more likely to work effectively in the clean boiler rooms of an oil-driven ship than in a coal-fired vessel, where there is necessarily a considerable amount of dirt and dust. Finally, in case of fire, oil fuel, being distinguished from coal by the fact that there are no interstices in the oil, has the advantage that fire-extinguishing apparatus can work to much greater advantage.

Mr. Hoover on the American Merchant Marine

IN the opinion of the Secretary of Commerce, it is simply a truism to say that we must have an American overseas marine. Apart from the impulse of fine sentiment and national pride, which renders a great trading nation desirous of maintaining its flag upon the seven seas, we need ships of our own for the protection of our foreign trade; for the expansion of our export on sound lines; and as an auxiliary to our national defense. Many of us have not forgotten that when President Roosevelt sent our fleet around the world, it had to depend upon foreign bottoms to carry the necessary coal for refueling.

Our international trade is one of the very foundations of the American standards of living, for our daily comfort depends upon the importation of those things which we cannot ourselves produce. Among these are such commodities as rubber, coffee, sugar, tin, to say nothing of a score of others. Mr. Hoover points out that, in the main, the amount of these commodities which we can import will depend upon the amount we can export.

If we are to have secure export markets we must have a certain amount of American-controlled shipping, in order to protect us against combinations in rates which would prejudice our goods in competitive markets. We are told that, since the war, the facility of the world at large in creating combinations in restraint of trade has been growing by leaps and bounds, and although we endeavor to curb these activities within our own borders, naturally we cannot do so abroad. There are, in fact, many commodities upon which we are dependent by import from foreign lands, where combinations exist for control of the price of those commodities. These unfavorable conditions do not cease at the seaport—they are very common in the shipping world. Our wheat, for instance, is sold in the world market in competition with that of other countries, and a farmer's return on wheat is fundamentally the price which he receives at Liverpool, less the cost of transportation and handling. Therefore, it is as important to him to be guaranteed reasonable rates of sea transportation as it is on freight carried by land.

Now, the real security amid these conditions lies in our possessing an adequate American-owned merchant marine. The expansion of our foreign trade will depend largely upon the assurance of dependable transportation. If our manufacturers are to be assured of prompt delivery our ships must sail regularly week by week; and our merchants and manufacturers must know that, when they have established a market for their goods in foreign lands, absolutely regular transportation will be assured to them for a period of years to come. In other words, they must not be left depending upon the hazards of foreign ships, working in combination with foreign merchants and competitors.

So, looking at the matter in a broad sense, the American people desire to establish a Merchant Marine that will adequately protect their commerce. What they wish for is a regular ferry-like service of boats of the mixed-cargo liner type, with moderate passenger accommodations, running on the great trade routes of the world and carrying at least 50 per cent of our foreign trade. Today, outside of oil, we are carrying less than 20 per cent.

The Unity of Mathematics

IN TEACHING more than in any other profession there is temptation to fall into a rut-bound conservatism. The inherently self-perpetuating character of this profession is responsible for the conservatism in question. Doctors, to be sure, get their training from their predecessors; but when they get out into their profession, they find the technique of practice so different from that of the class-room that there is every opportunity for them to keep their faces forward. But the teacher of this generation is the student of last generation; and when, as teacher, he deals with his students, he finds himself in exactly the same situation that his former teacher occupied in dealing with him. He may meet this in a manner highly inspirational, but only occasionally may we expect to find him developing sufficient initiative to question the fundamentals, and to wonder whether the manner in which his subject was taught to him is, after all, the one-and-only, God-given way to teach it.

In the face of this general observation, it is gratifying to survey the collegiate field and to realize that in most departments of instruction the past two decades have seen more or less complete overturns of old practice. Classical languages as well as modern, English and history as well as physics and chemistry—all these are being taught in a fashion quite foreign to, and unquestionably better than, that of an earlier generation. And at the moment, the teaching of collegiate mathematics, in which the iron rule of tradition dates further back than in any other branch of instruction, is undergoing a similar transformation.

Since mathematical knowledge became sufficient to support such a partitioning, mathematics has been carefully fenced off into algebra, trigonometry, analytic geometry and calculus. Under the plan of study thus imposed, the student can form no conception of the character and possibilities of modern mathematics, nor the relations of the several branches as parts of a unified whole, until he has taken several successive courses covering, at best, two and a half years. Unless he be a student of exceptional insight, he will in fact master the technique of these separate courses, without ever realizing that fundamentally they all deal with the same thing. He cannot get, early enough, the elementary working knowledge of mathematical analysis, including the differential and integral calculus, which he needs so badly in his other work. He must study many subjects apart from their application in other fields, thus missing their full significance and gaining little facility in drawing upon one subject for help in another.

Suppose that a carpenter's apprentice were obliged to drive nails by shooting them from a shot-gun, and were obliged to master this technique as a prerequisite to being introduced to the more effective tool, the hammer? Absurd, of course; but not one whit more absurd than what is done in collegiate algebra and analytic geometry classes today. The tools of the calculus, simpler and more easily mastered than the roundabout methods of algebra and analytics, are deliberately withheld. The student is obliged to master a complex technique which he is later to discard completely; for two years he is obliged to attain his results in the roundabout fashion prescribed by that technique. This is exactly as sensible as telling the prospective carpenter that hammer and nails are fundamentally different tools, and that he must meet and master them separately. Algebra, analytics and calculus are not inherently separate subjects; they are all one, and should be so taught.

Of recent years there has been a notable trend toward the reintegration of the mathematical field of instruction, and the presentation of the subject in a single continuous course, which naturally revolves en-

Our Point of View

tirely around the concept of the function—the one thing common to all mathematical analysis. One takes up the study of a certain type of function and pursues it to its end without interruption. The work is classified according to the material, rather than according to the tool. It is interesting to know that one can whittle with a screw-driver, if one have no other tool; but if one have the proper tool, the possibilities of the improper one are not worth much examination. In the mathematical as in the mechanical case, there is no valid objection to the early use of the proper tool.

But however we present the subject we must have texts; and the texts which have been available in unified mathematics have been a pretty sad lot. They have been sad in their choice of material, sad in its order of presentation, and especially sad in the degree to which they have made it appear that they were different simply as a matter of faddism, for the sake of being different. We have in fact been so disgusted with them that we have often seriously considered the notion of writing, ourselves, a text in unified mathematics as, according to our lights, it ought to be written.

Prof. Frank L. Griffen, of Reed College, Portland, Ore., has made it unnecessary for us to harbor this idea any longer. What we had in mind, he has done. His "Introduction to Mathematical Analysis," published last fall, hits the mark squarely. From his introductory chapters presenting the basic ideas of the function, the rate and the limit, right through to the end, he gives a thoroughly sound and logical text in the mathematics of the function—free from frills, free from fads and fancies, and in just the right order. If we had our way, every teacher of mathematics would be obliged to read this book, and every person with responsibility for the laying out of mathematical instruction in any of our colleges would be obliged to read a chapter from it every morning before breakfast.

The Hydrographic Office and the Politicians

THE politicians in Washington are trying to get that admirable institution, the Hydrographic Office, away from the Navy and into their own control. If they succeed, the result will be a greatly lowered efficiency for a greatly increased expense and—an added number of comfortable berths to be dispensed among the faithful.

This is the third time, in the past fifteen years, that an assault of this character has been made, and for the third time the SCIENTIFIC AMERICAN, after a very careful and thoughtful investigation of the question, goes on record as most strongly opposed to the proposed change. A movement which is excellent in itself, such for instance as the present consolidation of bureaus and departments in Washington, may be pushed too far; and we believe this proposed transfer of the Hydrographic Office is a very clear case in point.

The Hydrographic Office is a branch of our naval activities which, for nearly a century past, has been producing charts, pamphlets and nautical literature for the guidance of navigators, both in the Navy and in the Merchant Marine. That its work is indispensable to the Navy goes without saying; and if the office, or rather the duties of the office, were transferred to the Coast and Geodetic Survey, as is proposed, the work would have to be carried on by the Navy just as it is now, if only to furnish its ships with absolutely reliable information as to currents, tides, winds, soundings, reefs, etc. Hence, the transfer would be a direct duplication of work.

Not only has the Navy, for a century past, been providing its own ships with this information, but it has been cooperating very closely with the American Merchant Marine, the captains of whose ships regularly furnish the Hydrographic Office with reports of the location of wrecks, derelicts, ice, and any other information affecting charts or sailing directions. That this cooperation has been complete and effective is shown by the fact that the Merchants Association of New York, during the last assault of the politicians, passed a series of resolutions requesting that its Board of Directors strongly oppose any legislation designed to have the Hydrographic Office transferred to the Department of Commerce. And they also made what, to our thinking, is a most sensible and obvious recommendation that, if economy is being sought, instead of the Hydrographic Office being taken over by the Coast and Geodetic Survey, the work of the Coast and Geodetic Survey should be incorporated among the duties of the Hydrographic Office.

For a long term of years preceding the Spanish War, the work of coast survey was done by naval officers; but during the war they were called away. The work was taken up by landsmen, and the politicians took care that it was never returned to the Navy. Upon the transfer, appropriations for Coast Survey were trebled and today they stand at: Hydrographic, $495,000, Coast and Geodetic, $2,195,975.

As to the Hydrographic Office, at present the work is in the hands of men whose duties take them to every part of the world, to far distant harbors, to remote ports, and at times to routes of sea travel which are removed from the main highways of the ocean. Their naval duties call them there, and the work they do for the Hydrographic service costs not a cent of the nation's money. There is no body of men that could hope to do it so well or at such little expense.

But let us take a look at the other great maritime nations of the world. How do they manage their affairs in respect to hydrographic work? They do it exactly as it has been done and is being done by the United States Navy. In every case, the Hydrographic service is carried on by the naval officers of the respective naval services. They all maintain hydrographic offices as vital parts of their Navy Departments; and in all naval countries, except our own and Portugal, the charts both of their own coasts and of foreign waters are made by the officers of the respective navies. In our own country our coastal charts are made by the non-seagoing forces of our Coast and Geodetic Survey; and although our Hydrographic Office makes and publishes some 7200 charts of foreign waters, *it is barred by law from making surveys in its own waters.* Can you surpass this for absurdity?

The Hydrographic Office is in competent hands, and with a moderate staff of 464 officers and men stationed at 16 different ports and on the high seas, it does its work with remarkable efficiency. The Coast and Geodetic Survey employs over twice that number of civilians. If the Coast Survey were restored to the Navy, the Navy will tell you that it could do both the hydrographic and coast survey work with a minimum of men, and do it for a mere fraction of the present cost.

A Problem in Helium-Filled Airships

THE man who first designs a condenser for recovering the water from the exhaust of airship engines, that is so light as to involve but a small addition to the load carried by the ship, will make a valuable contribution to the success of helium gas as the medium of sustentation.

As everyone knows, the operation of an airship involves a continual loss of the gas whether it be hydrogen or helium. This is due to the fact that the consumption of fuel by the engines causes a diminution in the total weight of the ship, with the result that it tends to rise above the level at which the pilot wishes to navigate. To counteract this a corresponding amount of gas must be allowed to escape.

Now the obvious method of restoring the balance without the present discharge of gas would be either to take weight aboard during flight, which is impossible, or to find some means within the ship itself by which the change in its weight can be prevented. It has been recognized that if the water in the exhaust from the engines could be recovered, a long step would be taken in the solution of the problem; and much inventive ability has been directed to the invention of a means by which these gases can be condensed and the weight of the water thus recovered retained as part of the ballast of the ship.

The problem, of course, is not so serious in a hydrogen-filled ship, because of the comparative cheapness of that gas; but when we come to consider helium, which costs at present about $30 per thousand feet, it can be seen that the continual venting of the gas must represent a very large item of expense in the operation of such a ship as "Shenandoah."

The Automobile in the Test-Tube

SATISFACTION is not for the research engineer. The moment he becomes satisfied, he ceases to work; conversely, the more dissatisfied he is with things as he finds them, the better the job he is going to turn out. A critical, pessimistic, but, withal, a true appraiser of relative values, this research person, who only too often is called in on a problem at the eleventh hour by the worried industrialist, to save a very sick product.

Now the modern automobile is by no means a sick product. Far from it, the automobile is a great commercial success. It has become an everyday necessity, as well as a means of enjoyment. And because of its enormous popularity, the public has come to accept the present-day automobile as a highly developed, finished, virtually unimprovable piece of mechanism. True, there might be certain refinements and even radical changes in certain features, such as the traffic transmission, the four-wheel brakes, the balloon tires and so on; but so far as the basic design of the automobile is concerned, it has been considered as solid as the Rock of Gibraltar.

Somehow or other, the research engineer has been given an opportunity to place the modern automobile in a test tube, figuratively speaking. In analyzing the matter, the research engineer has made numerous discoveries. For one thing, he has taken up the features of the modern automobile one by one, and determined whether they were fundamentally correct or merely based on custom. That procedure has been the opening wedge, just as it is in any research work. Doing the same thing in the same old way year after year does not meet with the research engineer's docile acquiescence.

Then, too, the research engineer has tried a little chemistry on the automobile. He has studied what actually takes place in the automobile engine cylinder, and has learned that there are two distinct kinds of explosions—one, a violent detonation, which cannot be harnessed and which is, therefore, undesirable because it produces a "knock"; the other, a gradual expansion which is harnessed and converted into driving power. Chemistry has shown the way to eliminate the "knock" of the violent explosion, in the form of a teaspoonful of "dope" for each gallon of gasoline used. "Doped" fuel, it is said, will permit the use of higher compressions in automobile engines, and higher compressions, in turn, will result in smaller engines for a given power. Chemistry, too, has been applied to the carbon deposits in cylinders. The real nature of carbon has been determined, and now we are about to have a carbon remover which really removes carbon.

The mechanical side of the automobile has been studied, revealing much that is merely a matter of custom. The three-speed gear shift alone is a challenge to the research man, and he has promised to answer in due course. The cooling of automobile engines by means of water jackets and radiators is another feature which the research man refuses to accept as a fundamental, and already he has worked out ingenious ways and means of welding copper ribbons to cast-iron cylinders for efficient air-cooling operation—doing one of those things that can't be done.

The automobile is in the test-tube. Shortly we may expect still more startling developments than those already displayed to an appreciative public, because the research engineer is on the job.

Our Psychic Investigation Advances

We Find a Medium Whom We Cannot Characterize as a Conscious Fraud

By J. Malcolm Bird, Secretary to the Committee of Judges

The medium, as tied for the third sitting by Houdini. From these bonds no escape was possible. Note seal between chair and baseboard

NINO PECORARO is an Italian youth of 24, a native of Naples and for several years a resident of New York. In both cities he has enjoyed the patronage of Dr. Anselmo Vecchio, who was physician and friend to Eusapia Palladino, the medium. During her last illness Palladino promised to return to Dr. Vecchio.

Having accidentally discovered in Nino what he took to be mediumistic powers, Dr. Vecchio took charge of him, with the idea of developing him to a point where Eusapia could use him. The result can best be indicated by an outline of a typical sitting with Nino; in this, it is obviously convenient to speak as though all that occurs were conceded to be genuine.

Nino is clothed in garments which have been searched, and tied into a chair with the idea of making it impossible for him to get effective freedom of hands or legs. In the cabinet, half a yard or so from him, is placed a table or another chair with bells, tambourines, trumpet, etc. A faint red light is in the room. After a short time, snoring is heard, followed by a whispered voice in Neapolitan dialect, Palladino's sole mode of speech. The sitting consists in good part of conversation between Palladino and the doctor, who translates when there are English-speaking sitters; occasionally other controls slip in for a few words. On the physical side, all the apparatus is freely used, and in addition there are raps and hand-clappings. Most of this comes in response to direct request from Dr. Vecchio, but a good proportion is spontaneous. Sometimes there is an attempt at materialization of hands or production of ectoplasm outside the cabinet. Palladino promises everything in the psychic catalog with the utmost recklessness, so that even the doctor does not take her seriously here.

At the end, the condition in which the bonds are found is highly variable. Once they were cut into fragments and piled in a corner, with the medium quite free; whereupon, Nino having been searched, Dr. Vecchio pronounced the demonstration as his most marvelous achievement, the implication being that he had been freed psychically. Usually, I believe, the ropes are considerably disarranged. This is more significant with Nino, alone in the cabinet and free from all control save that of his bonds, than with a medium like Powell (SCIENTIFIC AMERICAN, August, 1923), who gives good control by the sitters in addition to that of the ropes.

When the ropes approximate their original condition, objection may be entered to the method of tying usually employed. The medium wears heavy mittens, each of which is sewed, all around, to the coat sleeve. The arms are then placed together, horizontally, each hand at the opposite elbow; and around this ensemble wire is wrapped from end to end. It seems probable that the medium could free his shoulders from his coat, as a preliminary to removing hands and arms bodily from gloves and sleeves; and that the wire would then insure the permanency of this assembly until he was ready to return to it. When I have sat informally with Nino, the coat has been of such cut, fit and material as to support this suggestion.

Some time after Palladino's death, Dr. Vecchio missed $35, under inexplicable circumstances. He asked her through Nino what she knew about it, and she said she had stolen it, explained for whom she wanted it, and promised to repay it in installments, through Nino. She has made several payments, totalling $16, so she still owes $19. In his psychic scrapbook the doctor has preserved all the one-dollar bills obtained, together with numerous other apports; but a ten which she is stated to have paid on one occasion is missing—

The ropes as they looked at the beginning of the second sitting

the doctor is no millionaire. The ones are perfectly good dollar bills; if genuinely psychic, they are apports and not materializations. So Eusapia may get in difficulties with the police, but not apparently with the Federal Secret Service.

Well: the major basis for regarding Nino as a physical medium lies in his manipulation of the bells, tambourine and trumpet. How is this done? Nino is, of course, in trance, and doesn't know. Dr. Vecchio is clear that it is engineered by Palladino, but he makes no suggestion covering the *modus operandi*. Aside from outright fraud, there are four hypotheses which, though they will impress some as absurd, are valiantly supported by others.

I: That Nino remains in his bonds, the work being done by ectoplasmic structures extruded from his anatomy, and returned at the end of the sitting.

II: That by a process of dematerialization and reassembly, defined no further than these words define it, Nino's members are freed without disturbing the bonds, used as the physical tools of the sitting, and restored to their original status in a manner matching their removal.

III: That such release and return is effected, not by dematerialization, but by passing into the fourth dimension, which this hypothesis presents as a physical reality though not defining it with any precision.

IV: That the phenomena are produced by an externalization of energy rather than of matter, the obvious analogies being with the light wave and the radio impulse.

All these theories have some connection with spiritualism; but it must be emphasized that if any of them is realized, it is psychic, regardless of the nature and identity of the operators. Psychic, we recall, means nothing more than "not yet understood."

If we find the apparatus marked with the medium's finger prints; if we smear it with some sticky substance and find this on the medium; if an electric circuit is closed through the medium's body and the bell; if in any other way we show that the medium has handled the apparatus directly—then Hypotheses I and IV are ruled out. We may not be so confident about II and III, however. Indeed, one might wonder whether it is possible to convince a spiritist that, in any given case, fraud rather than dematerialization or the fourth dimension, has been at work. However one attempts this discrimination, it involves a very nice balancing of facts, inferences and probabilities. For instance: when one has tied the medium so that one hopes he will be unable to get any slightest use of hands, feet, mouth, knees, chest muscles, toenails or eyebrows, shall total failure of physical phenomena be laid to success in ruling out fraud, or to bad psychic atmosphere? It is easy to jump at an answer to this question, but far from easy to demonstrate that the answer thus obtained is the correct one.

This problem, as presented by Nino's case, was brought before our committee in December. We sat on the 10th, 14th, 18th and 21st in our law library. The committee and the SCIENTIFIC AMERICAN were represented by Dr. Prince, Dr. Carrington, Houdini, Mr. Lescarboura and myself. Outside aid was had from Dr. Siegfried Block, neurologist, and Drs. G. B. Stearns and W. J. S. Powers, general practitioners, whose observations and opinions were of great value.

At the first sitting we had a very large cabinet, nine feet by four. The medium wore his own one-piece undergarment, and Dr. Block's overcoat. Gloves and wire were used on his hands and arms as described above. The right glove was sewed to the coat sleeve, the left to that of the undershirt. The rope used to tie Nino into the chair was too hard for best manipula-

(Continued on page 115)

At the end of the second sitting, there was every indication that there had been a partial attainment of freedom

Our Abrams Investigation—V

A Statement of Our Findings to Date and the Prospects of Further Demonstrations and Tests

As Reported by Austin C. Lescarboura

Secretary to the SCIENTIFIC AMERICAN Abrams Investigation Committee

THE longer our Abrams investigation continues the more we begin to wonder whether we are the *investigators* or the *investigated*. Our original intention was to study at first hand the phenomena claimed for a new method of diagnosis and treatment known as the Electronic Reactions of Abrams. We fully expected this investigation to follow the usual scientific procedure which aims to establish the facts in the most direct and positive manner. We were prepared, however, to make due allowances for the delicacy of such forces and variable factors as might be involved in this sensitive technique. Lastly, we had reasons to believe that Dr. Abrams and other electronic practitioners and experimenters would facilitate our work in every way by extending their utmost cooperation, to the end that the truth of the so-called electronic reactions might be established once and for all.

To date, and after four months of patient and persistent investigation, the tangible results are frankly disappointing. The cooperation promised us by Dr. Abrams himself has, so far, fallen far below our expectations, for no better reason than the fact that Dr. Abrams and ourselves do not agree on what constitutes a scientific investigation. Dr. Abrams insists that we must visit his laboratory in San Francisco, there to witness his work and become familiar with electronic technique. He has impressed this view on many of his followers, who have not failed to criticize us for our reluctance to hasten to electronic headquarters. Meanwhile, we have proposed a series of blood-specimen tests, which could be conducted at this time with the minimum of trouble on the part of Dr. Abrams as well as ourselves, and which would be far more evidential than any series of demonstrations at the San Francisco laboratory.

We have already reported our proposal to Dr. Abrams. Briefly, we formulated a series of blood-specimen tests to be undertaken by Dr. Abrams under the same conditions as he diagnoses dozens of blood specimens received from all parts of the country and even abroad, day after day. The specimens would be prepared with utmost care, according to electronic practice. We would even permit the specimens to be prepared by a representative of Dr. Abrams, although such procedure would weaken our rigid test conditions to some extent.

The long and short of the matter is that Dr. Abrams, thus far, has refused to undergo a series of blood-specimen tests, on the grounds that his findings could not be compared with clinical diagnoses, inasmuch as the two kinds of procedure do not agree. This is rather puzzling at this time, inasmuch as the various disease "rates" were originally determined by taking known clinical cases and working out their electronic values. Today, however, the electronic diagnosis and the orthodox diagnosis very often fail to agree, for the reason, we are told, that they are based on divergent techniques. If "A" once equalled "B," at this time "B" no longer equals "A"; yet we are asked to accept the established "rates" for various disease conditions as final. Furthermore, we are asked to believe that the electronic diagnosis is far more critical than orthodox methods, so that it often discloses diseased conditions in their very incipiency, months and even years before they are developed to the point where they are disclosed by the more conventional diagnosis. Hence another reason why E. R. A. findings so often fail to agree with the obvious facts in the case.

To make matters still worse, Dr. Abrams has on several occasions asked his leading men not to make tests for us. Several weeks ago we went to considerable trouble to formulate a blood-specimen test which was of the most elementary character. We were to have the cooperation of a New York doctor, who is friendly to the E. R. A. cause, supervise the preparation of the blood specimens. These specimens were to be taken from patients in the last stages of tuberculosis, cancer, syphilis and perhaps one or two other common causes. There could be no question regarding the accuracy of the clinical findings—indeed, any layman could determine at a glance the true nature of each case. Furthermore, to make the test still more convincing and to eliminate, if necessary, the comparison between electronic findings and clinical findings, we were prepared to submit a number of specimens from the same patient, so as to determine whether the E. R. A. diagnostician would check up successfully on his own findings. Finally, to simplify the matter still further, the E. R. A. diagnostician was to be furnished with a list of the several diseases represented by the specimens, as well as the number of similar specimens. What could be simpler and fairer? How elementary compared to the everyday wonders of E. R. A. diagnosis!

Just as we were on the very threshold of making a genuine test with a genuine E. R. A. diagnostician under genuine E. R. A. conditions, our hopes were suddenly and unexpectedly shattered by word through the diagnostician's representative that Dr. Abrams had telegraphed the diagnostician, forbidding the test. Our disappointment was beyond description. Nevertheless, this case is typical of the general evasiveness of E. R. A. men and E. R. A. technique in the matter of submitting themselves to honest, sincere, convincing investigation. More than one investigator has lost all patience in trying to get to the bottom of the electronic reactions of Abrams, and has given up the subject in utter disgust.

One word regarding a visit to the San Francisco laboratory of Dr. Abrams. We appreciate the invitation. We may yet avail ourselves of same, if it is found to be a necessary procedure later on in our investigation. However, for the time being a visit to the San Francisco laboratory is quite unnecessary and beside the point. We are interested first and last in the electronic reactions from a drop of blood—in the technique itself—and not in Dr. Abrams himself, except in so far as he practices the electronic technique. Dr. Abrams, if we understand the matter correctly, by no means has a monopoly on the electronic reactions, and he has taught several thousand doctors how to elicit and interpret the reactions. That being the case, we feel called upon once more to state that we can test the validity of E. R. A. claims with the cooperation of any skilled E. R. A. worker.

Meanwhile we are severely criticized by E. R. A. workers and their patients. Why do we not accept Dr. Abrams' claims without further ado, inasmuch as no further evidence is required? Why bother with a scientific investigation, when tens of thousands of cured patients present undeniable evidence of the efficacy of E. R. A.? Why do we hesitate to go to San Francisco, when we have been so persistently urged to do so? Why do we wish to prevent this great truth from being revealed to suffering humanity? And so it goes. Assuming, for the sake of argument, that E. R. A. is a genuine technique, the world at large must wonder why so many obstacles and so much confusion are cast into the very face of all investigators.

In his last letter to us, Dr. Abrams announces his departure for the East early this year, at which time he promises to place his methods before unprejudiced scientists in the same way as other innovators have done. This, to our mind, will do much to clarify the present unfortunate situation. Pending its realization, we have no further comment.

As regards E. R. A. practitioners in general, we have had nothing in the way of tests, with the single exception of the Dr. X episode reported in our November issue. What is more, E. R. A. practitioners are now organized into various societies and associations for the purpose of closer cooperation among themselves. As a consequence, individual E. R. A. practitioners have been discouraged from cooperating with us as individuals. From now on, all official cooperation with the SCIENTIFIC AMERICAN Abrams Investigation Committee will have to come from a committee duly appointed by the respective electronic organizations. While we may be successful in receiving some cooperation here and there from individual practitioners, it is certain in advance that such practice will be discouraged by E. R. A., and the results, if detrimental, will be repudiated.

At least one of the E. R. A. associations is going about this work in a business-like manner, so it seems. All its members have been queried by means of an elaborate questionnaire, regarding their appraisal of E. R. A. claims and provable possibilities. The consequence so far is that many of the more fantastic E. R. A. claims have been denied, and we are slowly but surely getting down to the bedrock of the matter.

As for our four months of investigation, we have accomplished more than would appear from surface indications. As the results of numerous interviews, demonstrations, studies of case histories, discussions with E. R. A. workers and E. R. A. investigators and E. R. A. experimenters, we have established definite findings regarding E. R. A., which are published in the accompanying list. These findings stand as stated here, unless they can be shattered through tests or positive proof to the contrary. For the most part, these findings are in full accord with the beliefs of the more conservative E. R. A. workers themselves.

AFTER four months of patient and persistent labors, our Abrams Investigation Committee inclines toward the following conclusions based on tests, demonstrations, observations, and statements given ir interviews and correspondence with Dr. Abrams and his followers, as well as non-E. R. A. electronic practitioners:

1. **The public over-estimates the diagnostic and curative powers of E. R. A. Electronic workers admit that its possibilities are far below the fantastic claims set forth by enthusiastic writers of E. R. A. literature.**
2. **If E. R. A. is a genuine technique, then it is in its very infancy—crude, uncertain at times, and subject to changes from month to month, much as a laboratory experiment.**
3. **E. R. A. does not take the place of older diagnostic methods, according to numerous E. R. A. workers. Quite to the contrary, it may be employed only as an accessory, in which connection it is claimed to be useful.**
4. **Assuming that the so-called electronic reactions do occur, and that they represent recognizable and determinable rates: the correlations claimed between these rates and certain pathological conditions are by no means proved. The assumption that a rate of 57 corresponds with a syphilitic condition, 42 with a tubercular one, etc., is admitted by persons high in the E. R. A. councils to be entirely empirical.**
5. **E. R. A. diagnosis is seemingly such a delicate procedure and is fraught with so many detrimental factors and variables that there is an ever-present danger of grave error. The preparation of blood specimens, the condition of the reagent and diagnostician, and other factors are claimed to have a marked influence on the accuracy of the E. R. A. findings.**
6. **All E. R. A. practitioners are by no means competent to make a satisfactory diagnosis. Many of them have proved unreliable in this work. Few of them are qualified, according to E. R. A. admissions, to undertake a scientific test aimed at appraising the value of this technique. When one seeks a competent and authoritative test of the Abrams technique, on the basis of which judgment may be formed as to its validity, one is told that the only person competent to undertake the work is Dr. Abrams himself. No other practitioner is competent to make a determination on which Dr. Abrams seems willing to have his system judged; yet every day his authorized disciples all over the country make thousands of determinations upon which the lives of their patients depend.**
7. **Spectacular features, such as determining the race of an individual, his religion, his exact location at the moment of diagnosis, his emotions and matters of the heart, are not to be taken seriously.**
8. **There is a tendency on the part of E. R. A. workers to modify the claims made for the oscilloclast treatment. It is not claimed to "cure" in the usual sense of the word. It does, so it is claimed, reduce the potentiality or "ohmage" of the disease energy. Whether or not a "cure" is effected following the oscilloclast treatment is a matter for nature's own forces, which are now given an opportunity to function, if we accept E. R. A. beliefs.**
9. **There is a grave discrepancy between the crudity of the Abrams apparatus and the extreme refinement of the results claimed from its use. As a specific example, the resistance boxes used have an uncertainty in the precise establishment of contact between switch lever and contact point greater than the ohmage difference between successive points, yet readings are made with the utmost confidence. In other respects, too, the accidental error involved in the use of such crude apparatus would seem to be greater than the differential between the rates, etc., to be determined.**
10. **There is much confusion in electronic ranks regarding the basis for their technique. Dr. Abrams and his followers have been using the terms electrons, ohms, waves, phase and so on rather loosely. Some are beginning to realize this fact.**
11. **E. R. A. is not a satisfactory subject for a scientific investigation. Numerous obstacles are placed in the path of investigators, until patience is taxed beyond the utmost limit. Promises upon promises are made, while precious time, which might be put to other use, is being lost. Yet all the while we are assured that E. R. A. desires to prove its case to the scientific world, through an impartial and truly scientific body of investigators. We have presented E. R. A. the opportunity. Will they accept it?**

What Is Sleep?

OMITTING all confusing detail, sleep may be defined as a periodically recurring state of the animal organism during which all conscious activities are suspended. From the viewpoint of science, however, this definition is not satisfactory because it is incomplete. It gives merely the negative characteristic of sleep, the absence of conscious activity, without stating what actually takes place during sleep. That sleep is necessary to the animal organism was common knowledge, learned from experience, many thousands of years ago, but even now the mystery of the why and wherefore of sleep remains partly unsolved.

In a general way it was recognized long ago that sleep is a period of rest during which the body recovers the vitality depleted by the physical and mental activities during the preceding period of awakeness and the various tissues regain their normal state by the elimination of waste products and the building of new tissue. The exact nature of the chemical and physiological changes involved in this process of restoration has been studied with great care in recent years and many important facts have been ascertained which throw interesting light upon the metabolism of the animal organism and, more specifically on the part assigned by nature to certain glands.

One of the most important discoveries was made in the course of investigations concerning the pre-natal life of the human infant. It was found that neither the blood nor any other part of the human foetus contained even the slightest trace of free iodine, excepting in the imperfectly developed thyroid gland. As it was already known that it is one of the functions of that gland to extract iodine from the blood and to supply it when and where it is required to counteract the toxic effect of the poisons and waste products generated or cast off by the tissues of the body during labor, the absence of free iodine in the unborn child led to the inference that a definite relation existed between that fact and the restful period of nine months of unbroken sleep which the child enjoyed previous to birth. It was found that the muscular effort of the new-born child's first cry immediately stimulated the thyroid gland to send a supply of the powerfully anti-toxic iodine through the body of the child, counteracting the poisonous effect of the fatigue products generated by the activity of the muscles and other tissues involved.

It is well known that infants, during the early part of their life, require a great deal of sleep, far more than the mature individual. This may be accounted for by the fact that in the new-born child the thyroid gland is imperfectly developed and, therefore, incapable to supply an adequate amount of iodine. The gland soon becomes exhausted, the fatigue poisons paralyze the nerve center and the infant falls asleep. During the long period of rest the thyroid gland accumulates a new supply of iodine with which it can provide the organism during the next period of awakeness. As the child grows older, the power of its thyroid gland to supply iodine increases; brain and muscles of the child become capable of greater exertion without fatigue, because the gland can send more iodine into the system to counteract the effect of the poisonous fatigue products and, as a result, the child requires less sleep. A child whose thyroid gland is defective and does not supply iodine will necessarily remain physically and mentally inferior.

The results of recent research seem to indicate that different types of men require different amounts of sleep and that the amount depends in a large measure on the relative balance between the thyroid and the suprarenal glands on one hand, the pituitary body and the sexual glands on the other. The adrenalin secreted by the suprarenal glands has a strongly stimulating effect on the thyroid gland and its secretion of iodine and, at the same time, causes an increase of blood pressure by the contraction of the blood vessels. Men, whose suprarenal and thyroid glands are healthy, and act in efficient harmony, are invariably high-strung, mercurial, mentally and physically extremely active and require much sleep. Their thyroid glands send an abundance of iodine through the system to counteract the poisonous products of muscular and mental fatigue, but, having become exhausted by the exacting demands on their ability to supply iodine, they require a long period of restful sleep to recuperate. Adults of that type usually need from eight to ten hours of sleep.

The extreme contrasting type which is found among the northern races, requires, as a rule, less sleep. His physical and mental activity is slower and less intensive and makes comparatively less demand on the iodine resources of the active and efficient thyroid gland. Men of that type are usually of larger and more powerful build than those belonging to the southern races. Though slower in their physical and mental activities, they are by no means intellectually inferior. Their life processes move more slowly, their energy is less rapidly used up and they often retain their faculties to a great age.

In the light of the results obtained by recent research, sleep may be defined as a periodically recurring state during which all conscious physical and mental activities are suspended as the result of the toxic effect of the fatigue products accumulated in the muscle and nerve tissue and of the inability of the exhausted thyroid gland to supply the iodine required to counteract the paralyzing effect of the fatigue poisons. As no further fatigue products are produced during the period of rest, the thyroid gland, continuing its activity, is enabled to catch up with the demand for more iodine and to accumulate a reserve supply.

Man's Erect Posture

THE *British Medical Journal* for March 17 contains an article by Sir Arthur Keith, on "Man's Posture: Its Evolution and Disorders." Sir Arthur points out that extinct forms of man indicate that the upright carriage of the head was evolved later than the human form of the lower limb, of which the origin must be sought in Miocene or possibly Eocene times. Three phases of evolution are distinguished. In the hylobatic phase the gibbon was differentiated from its cousins, the Old World and New World monkeys, by postural adaptations of bones and muscles in virtue of which it was orthograde and human in type as opposed to the pronograde monkeys. This differentiation probably took place towards the end of the Eocene period. The troglodytic phase was represented by the great anthropoid apes, evolved from the small anthropoids probably in pre-Miocene times. In the plantigrade phase, structural changes were confined almost entirely to the lower limbs. Seeing that man shares so many characters with the great anthropoid apes, the author held that man is one of several aberrant branches of one great stem which began to break up into the various fossil and living forms at the beginning of the Miocene or the end of the Oligocene period.

How Hafnium Was Discovered

THE recent discovery of hafnium, the latest addition to the list of chemical elements, is a remarkable illustration of the wonderful possibilities which rest in the scientific application of deductive methods of research in chemistry. The story of the discovery is a veritable romance of science.

The discovery of hafnium, which was named in honor of Copenhagen, the capital of Denmark (called Hafnia in its Latin form), was not an accident, but the result of investigations based upon deductions from the latest and most advanced conceptions of atomic structure, made possible by the discovery of the X-rays by Roentgen, the invention by von Laue of a method of obtaining a spectrum of the short-wave invisible light rays with the aid of crystal gratings, and the ingenious theories concerning the periodicity in the arrangement of the elements and the internal structure of the atoms contributed by Meyer, Mendelejeff, Rutherford, Bohr and the late physicist Moseley, who met with an untimely end in the trenches before Gallipoli during the great war.

In 1869 Mendelejeff and Lothar Meyer presented to the scientific world their discovery that the elements, when placed in the order of ascending atomic weight, showed a remarkable regularity of periodic nature, each element resembling most closely the eighth element beyond or before it in the list. From the results of subsequent investigations the conclusion was drawn that all the properties of the elements are periodic functions of their atomic weights. Certain irregularities and inconsistencies in the periodic system could not be satisfactorily explained, but the fact that three of the blank spaces in the periodic system were afterwards filled by the discovery of gallium, scandium and germanium, which showed physical and chemical characteristics closely corresponding with those that Mendelejeff had predicted for the then unknown elements, strongly supported the soundness of his theory and the significance of the periodic table.

The discovery of the Roentgen rays opened a wide field of research concerning the internal structure of the atoms which, until then, was merely a matter of scientific speculation. In 1912 Dr. Laue of the University of Zurich discovered that the invisible X-rays could be refracted by means of a crystal grating to give a spectrum that could be made visible by photography. Two years later Moseley, using different elements on the anti-cathode of the X-ray tube, found that the higher the atomic weight of an element, the shorter is the wave-length of the characteristic X-rays. He also found that, when the elements are arranged in the order of these wave-lengths, whole numbers can be assigned to each which are inversely proportional to the square roots of the wave-lengths of corresponding lines in their X-ray spectra. These numbers are called the atomic numbers of the elements.

Later, a simpler interpretation of the physical significance of these numbers was found, in terms of their electronic structure. Bohr, a Danish scientist, elaborating Rutherford's electronic theory of atomic structure, developed the doctrine that each element has as many planetary electrons in its atom as there are units in its atomic number. The nucleus, according to this theory, contains both negatively charged electrons and positively charged protons, with an excess of the latter; and about it there rotate orbitally enough "planetary" electrons to strike a balance between protons and electrons for the complete atom. Hydrogen, for instance, with the atomic No. 1, has only one planetary electron in each atom; helium, atomic No. 2, has two; and so on up to uranium, of atomic No. 92, which has in its nucleus 92 more protons than electrons, and is made electrically neutral by the presence of 92 planetary electrons. No more than two electrons revolve in the orbital range nearest the nucleus, no more than eight in either of the next two, and no more than eighteen in either of the next two.

The list of elements arranged in the order of their atomic numbers showed a break after No. 71, the element lutecium, the last in the known series of rare earths beginning with praseodymium, No. 59. No. 72 was lacking and it was not known whether the unknown element would prove to be one of the trivalent rare earths or not. Accepting Bohr's theory, that the element No. 72, could not be trivalent but must be quadrivalent, D. Coster, a Danish, and George von Hevesy, a Hungarian chemist, working together in Copenhagen, deduced that the unknown element would probably show great resemblance to element No. 40, zirconium, also quadrivalent, to which, according to the theory of Bohr, it must be closely related.

Patiently the two investigators examined the X-ray spectra of all zirconium minerals and chemical combinations of zirconium obtainable and in each case they found, in addition to the characteristic lines of the known element, lines of another, unknown element, in the exact position where in accordance with Bohr's theory the lines of element No. 72 should be. By a careful process of elimination the two scientists succeeded in separating the new element, which they named hafnium, from the zirconium, its invariable companion, and obtained it in pure form. It is quite common and forms approximately one one-hundred thousandth part of the earth's crust.

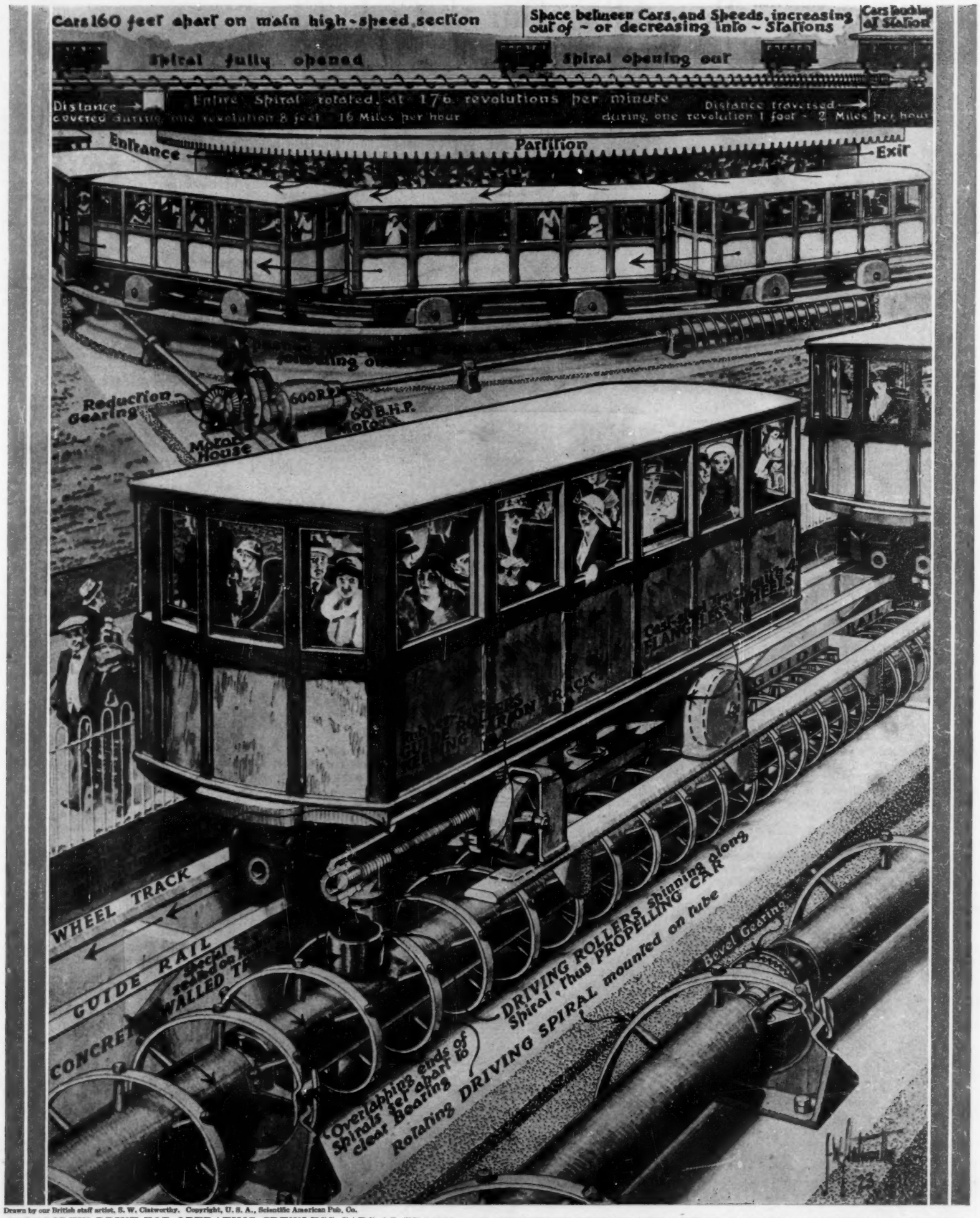
A Corkscrew Railway

AMONG the features of the British Empire Exhibition at Wembley will be a striking idea in railroad propulsion, devised by W. Y. Lewis and B. R. Adkins. Preliminary work has been started, and the installation is expected to be complete by April. The top sketch explains how the single cars (the system permits of coupled trains when desired) close up and slow down approaching a station; creep through in contact; and again open out and accelerate in leaving—the whole cycle being very smooth.

The middle sketch shows the cars at a station, where passengers merely walk in or out, the cars being entirely open on the platform side to give maximum accessibility. One method of driving the spirals is also indicated, seven electric motors like the one pictured providing the railway's entire motive power.

The large drawing, giving details of car and track, shows in the left foreground the ingenious bearing which is interposed without breaking the continuity of the spiral. At the right is the further modification used where changes of gradient or direction occur.

Approximate details for the Wembley installation are: a total of 80 cars in a 7200-foot line, a rush-service speed-range of 2½ to 20 miles per hour, obtained by rotating the spiral more quickly; six or seven stations with corresponding motors totaling some 400 horsepower, and a capacity in each car of 18 passengers seated and twelve standing. This gives a line capacity of 15,833 passengers per hour past a given point.


Cars 160 feet apart on main high-speed section
Space between Cars, and Speeds, increasing out of ~ or decreasing into ~ Stations
Cars backing at Station
Spiral fully opened
Spiral opening out
Distance covered during one revolution 8 feet - 16 Miles per hour
Entire Spiral rotated at 176 revolutions per minute
Distance traversed during one revolution 1 foot - 2 Miles per hour
Entrance
Partition
Exit
Reduction Gearing
600 R.P.M.
60 B.H.P. Motor
Motor House
WHEEL TRACK
GUIDE RAIL
Overlapping ends of Spirals set apart to clear Bearing
Rotating DRIVING SPIRAL mounted on tube
DRIVING ROLLERS spinning along Spiral, thus PROPELLING CAR along
Bevel Gearing

Drawn by our British staff artist, S. W. Clatworthy. Copyright, U. S. A., Scientific American Pub. Co.

CORKSCREW DRIVE FOR OPERATING CREWLESS CARS OR TRAINS: AN INGENIOUS BRITISH IDEA WHICH MAY BE AS PRACTICAL IN EVERY-DAY USE AS IT IS UNUSUAL.—(See facing page for details)

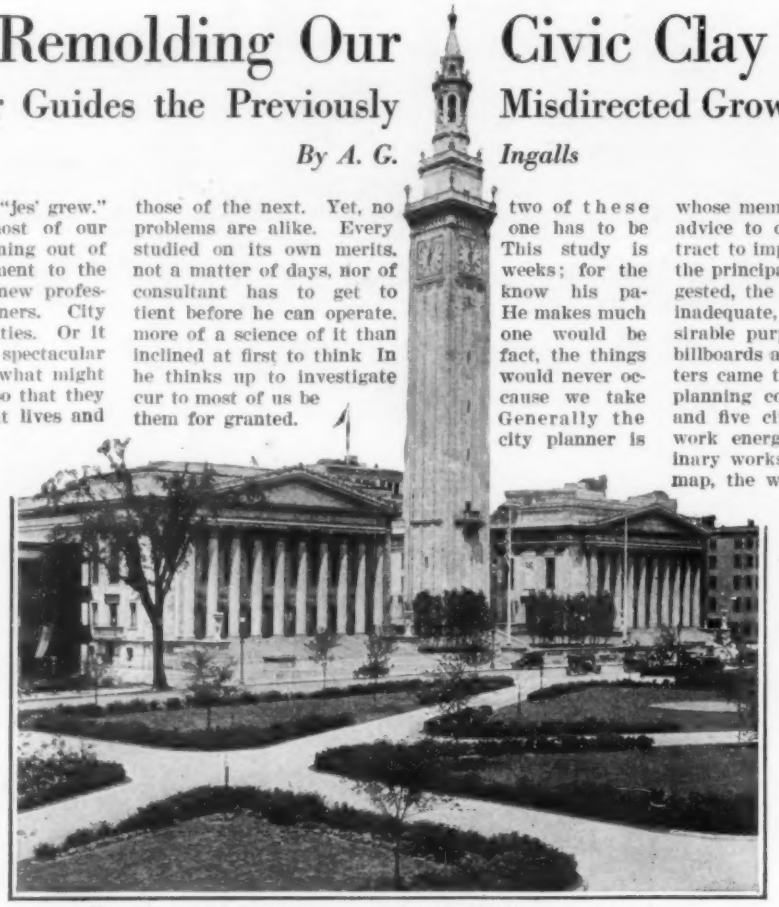
Remolding Our Civic Clay

How the City Planner Guides the Previously Misdirected Growth of Our Communities

By A. G. Ingalls

IN "Uncle Tom's Cabin," Topsy "jes' grew." That is the trouble with most of our cities and it is the straightening out of Topsy that is giving employment to the members of a comparatively new profession—that of the city planners. City planning suggests the laying out of new cities. Or it suggests the creation of civic groups and spectacular vistas. Mainly it is neither. Mainly it is what might be called the re-planning of existing cities so that they may be better places to live in and so that lives and money may be saved. The city planner cannot cut and slash. He would like to, but the taxpayers cannot afford it. He must coax. Under his hands a city must become plastic, but the remodeling of the clay must be done slowly.

The laying out of Washington, D. C., was a wonderful thing and a wonderful opportunity, but of such cities, planned from the start, the city planner deals with but few. Gary, Indiana, was such a city, and so were Delhi, the future capital of India, and Canberra, the federal district of Australia, which was laid out in the wilderness, a clean slate from the start. Of such jobs there are far from enough to go around. But the city planner has his living to make, therefore he takes old cities that have grown up wrong and tries to right them. Such work is not very romantic and not very spectacular, but it pays and it is decidedly interesting in the sense that it is a struggle against perplexing difficulties.



The Municipal Building, part of Springfield's new civic plan

The city planner is forced to make the best of what he has to work on. He cannot ask taxpayers always to indulge him in the most highly desirable solution of a given problem, because pretty often they can't and won't afford it. Knowing this he takes the next best solution and somehow makes a go of it. While he is on the job he does all that he can get sanction for and before he goes he leaves with his client a detailed plan which represents an ideal or distant goal for its citizens to work towards. Then, as the years go by and the city planner gets old and dies, and property deteriorates enough so that it may be torn out, the right changes may be made. Lacking such a definite and agreed plan as a common focal point for many minds people will always work, unconsciously, at cross-purposes, and thus our cities will remain hodge-podges without system. The time to catch them is when they are young. "As the twig is inclined, so the tree is bent."

Sooner or later the people of most communities arrive at the conviction that their physical environment is growing up wrong, that it is slowly crystallizing in forms that are hard to alter but which, nevertheless, must be altered. The job will never get easier. It will always become harder. Something must be done about it, they decide, and so the professional planner is called in to look the job over.

City planning has become a profession. Its members do nothing else. And the experience they get in working out the problems of one city are invaluable on those of the next. Yet, no two of these problems are alike. Every one has to be studied on its own merits. This study is not a matter of days, nor of weeks; for the consultant has to get to know his patient before he can operate. He makes much more of a science of it than one would be inclined at first to think. In fact, the things he thinks up to investigate would never occur to most of us because we take them for granted. Generally the city planner is an engineer—or he employs engineers, or is in partnership with them. In any case, he must and does know municipal engineering, while in the matter of matching wits with politicians and people with axes to grind he has cut his eye-teeth. He has made careful studies of his work both from a theoretical and a practical standpoint. He has saturated himself for years in its special literature, of which there are many five-foot shelves. And he has learned to catch the point of view of the average citizen of the average city without losing the sense of detachment that belongs to him because the new city is utterly strange to him at the beginning.

When he has been employed to diagnose and remedy the troubles of a community that has decided that it needs his services the city planner considers everything pertaining to the job under a number of heads. These are: streets; transportation of people; transportation of goods; factories and warehouses; food supply and markets; water supply and sanitation; housing; recreation; parks, boulevards and tree-planting; architecture; laws and financing. From this it will be evident that his work touches on the life of the city community almost in its every aspect and that in this regard we have come a long way from the two rather prevalent ideas that city planning is simply the laying out of new cities and the design of elegant civic centers for old ones.

Typical of the labors of a professional city planner are those of a New York corporation of city planners whose members are in the business of selling technical advice to communities. This corporation took a contract to improve the city of Springfield, Mass. In 1913 the principal streets of this city had become badly congested, the approaches to the big railway station were inadequate, the waterfronts were being used for undesirable purposes and the city had become a mass of billboards and advertising signs. These and other matters came to a head and forced the creation of a city planning commission consisting of three city officials and five citizens. This committee set about its new work energetically and recommended several preliminary works, such as the preparation of a topographic map, the widening of certain streets and the employment of experienced city planners to assist in creating a broad-gage scientific city plan. In 1921, after a long delay owing to the war, the commission was supplanted by a Planning Board. This board set about its task by asking two or three city planners of wide experience how they should start. As a result of the advice given, four leading city planners were asked to come to Springfield, look over the city and write a report as to what they thought the planning board could do, and, roughly how much it would cost.

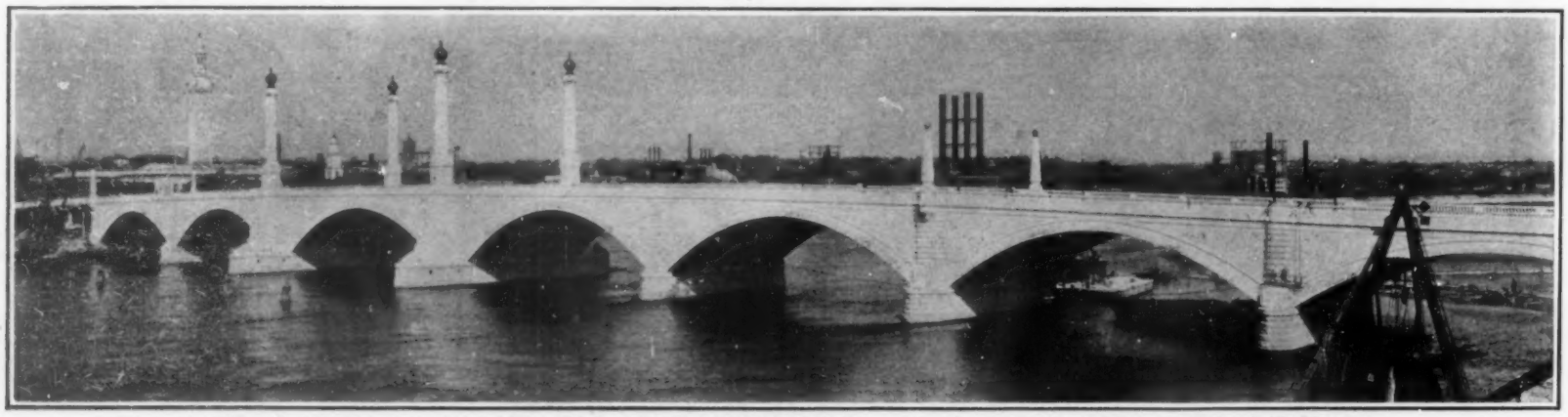
A little later a contract was signed with a city planner for a sum of about $40,000 to prepare a comprehensive city plan. In addition, another noted city planner was retained as an advisor. Working for the city planning corporation, from five to forty men were employed in presenting the required data, in map-making, and in making diagrams, tabulations and studies as well as in the preparation of reports. In all, nearly four thousand maps, charts, tabulations and studies were made and 25 reports were written, making up a rather voluminous report on what should be done to improve living conditions in Springfield.

It was found that Springfield was typical of other cities in its growth. Public garages, stores and even factories had been invading residential districts; numbers of apartment houses had been built out to the street line and to the side lot lines in the heart of the open, residence blocks where the homes had ample front and side lawns. Factories had invaded dwelling and tenement blocks and had spoiled good business streets. Eight-story buildings had been springing up among two and three-story buildings. In sum, the city had been growing without order and without direction.

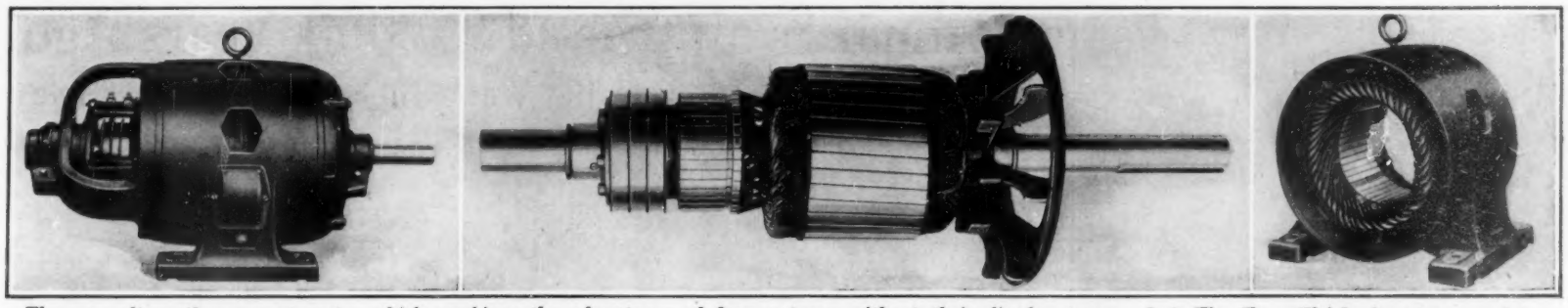
Here, then, was the opportunity for zoning. In a few years every community will regard the necessity of zoning just as they regard sidewalks or waterworks today. The purpose of zoning is simply to conserve all that is best in existing conditions and tendencies, and protect property against the harmful use of neighboring properties.

In order to learn the facts with regard to the character and intensity of use and development of each individual property in the city five or six men were kept busy for months collecting this data on some 400 maps. These facts covered such items as the use of

(*Continued on page 139*)



Hampden County memorial bridge, which replaced the old toll bridge across the Connecticut River at Springfield, Mass.



The new alternating-current motor which combines the advantages of former types without their disadvantages. *Left:* The Fynn-Weichsel motor complete. *Center:* The rotor or revolving member. *Right.* The stator or stationary member

A Motor That Solves the Power-Factor Problem

IN direct-current work the power, measured in watts, is the product of the volts and amperes in the circuit. In alternating-current work, however, this is only true when the current and the potential are in phase. If the current either lags or leads, the values shown on the volt and ammeters will not be true simultaneous values. Thus the power in an alternating-current circuit at any instant is the product of the simultaneous values of current and potential, and the volts and amperes shown on the recording instruments must be multiplied together and their product multiplied by a power-factor before the true watts are obtained.

Technical as all this may seem—and it is highly technical when reduced to the cold mathematics of the thing—it simmers down to the everyday fact that power-factor has an important bearing on electrical installations. A low power-factor on a system means greatly reduced capacity of generators, transformers, transmission lines, etc., and poor regulation of the entire system. It is, therefore, important to keep the power-factor as high as possible.

Within the last few years central station managers have begun to realize more and more that a considerable proportion of their equipment is idle as far as any return on the investment is concerned, some large distribution systems showing as much as 20 per cent or more of the total investment producing no return, due solely to the low power-factor of the connected load. One large central station alone shows an increased investment of over ten million dollars due to the low power-factor of its load. This is accompanied by an increase of operating costs, including both interest on excessive investment and actual cost of excess losses in the generating, transmission and distribution systems of approximately two million dollars. Stating the matter another way, if the load on this central station were a unity power-factor load—with current and potential in perfect phase—its yearly net revenues would be nearly two million dollars a year greater; and this is only one of a very large number of central stations.

It has remained for an American company to develop what is known as the Fynn-Weichsel motor, which is a radically new type of constant speed alternating current motor having a combination of the good characteristics of both the well-known slip-ring induction and synchronous types of motors, with those features which are undesirable from both the central station and users' point of view, eliminated. This motor may be used as a unity power-factor motor for complete installations, or in combination with other motors to produce a resultant load of unity power-factor.

The new motor, which is shown in the accompanying illustrations, consists of a stator with starting and operating windings, and a rotor with windings carrying the load and exciting currents. The rotor windings are connected to a commutator and slip rings of the usual construction. Brushes, bearing on the commutator, suitably interconnect the stator and rotor windings.

The Fynn-Weichsel motor has the very peculiar and desirable characteristic, if heavily overloaded, of dropping out of step and operating as an induction motor with induction motor characteristics. The value of this characteristic cannot be too strongly emphasized as it enables a motor to carry temporary excess overloads in the same way that the squirrel-cage or slip-ring induction motor will carry overloads, thereby making the motor just as stable and practical in its operation as present types of induction motor. The motor has the still further peculiarity that when the excess overload is removed the motor will again operate at synchronous speed—obviously a feature of the greatest value.

Making Plants Work Overtime by Means of Electric Light

THE value of electric light for accelerating the growth of plants was conclusively proved in a six-weeks' test recently completed by the Westinghouse Lamp Company. During the tests, which were conducted in cooperation with Peter Henderson & Company, seedsmen, at the Henderson proving grounds at Baldwin, L. I., many of the specimens exposed to electric light grew to approximately twice the size of similar plants receiving daylight only and were considered by experts to be from 14 to 27 days in advance of normal growth. Similar results were also obtained in preliminary tests conducted by the Westinghouse Lamp Company at Columbia University under the direction of Professor Hugh Findlay of the Department of Agriculture of the University. Two 110-volt farm lighting plants were used to supply the power for the Baldwin experiments, showing that the use of artificial light for forcing plant growth is not restricted to localities where central station power is available, but may be undertaken wherever current of any sort exists.

On September 1st, twelve varieties of vegetables and twelve of flowers were sown in shallow (three-inch) boxes, or flats as gardeners term them. The soil used was ordinary light, sandy soil such as is generally used for starting seedlings. Two sets of flats were sown, one set for growing under artificial light and the other for growing with daylight only. The following varieties of vegetable and flower seeds were selected for the experiment:

Snowball cauliflower, easy blanching celery, tender-green bean, bush lima bean, French forcing carrot, Davies perfect cucumber, butternut lettuce, scarlet giant radish, Egyptian beet, Rocky Ford muskmelon, bonny beat tomato, golden heart endive, Transvaal daisy, orange calendula, blue lace flower, baby's breath, snap dragon, lavender African daisy, impatiens, mignonette, wallflower, cincerari, begonia, aster.

Both sets were grown under identical conditions of heat and moisture on opposite benches. When the electric lights were turned on, an oil cloth curtain divided one group from the other. The light was switched on every night at 8 P. M. and shut off automatically at 1 A. M.

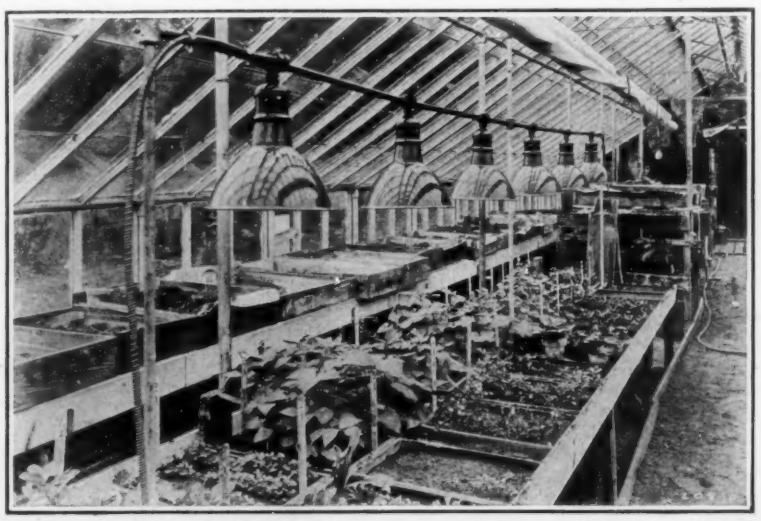
Almost from the outset there was a marked difference noted in the germination of the seedlings under the electric light. Germination was hastened in some cases, as in the beans, celery, lettuce, and endive among the vegetables, and calendula, gysophila (baby's breath), antirrhenium (snap dragon), mignonette, and wallflower among the flowers, to the extent of four to 12 days, depending on variety. The advantage gained with the advanced germination was maintained in every case through to the end of the experiment. In some cases there was no perceptible gain in growth, particularly in the root crops, including beets, carrots, and radishes.

That there is a certain analogy between the radiant energy of sunlight and that of an incandescent electric light was definitely established by the fact that the chlorophyll was more active in those plants which received the additional light. The foliage presented a richer, greener, more turgid, and vigorous appearance than that of the plants that were denied the advantage of additional light. Also in the case of the vine crops, cucumbers, and muskmelon, the stems of the plants were heavier and stockier than those of the plants grown without the electric light. In this experiment the fact was established that all plants presenting a large leaf surface are greatly stimulated by the supplementary use of electric light. Particularly good examples of this were afforded by the leaf crops, such as lettuce and endive.

The tests indicate that electric light will be useful to florists and gardeners in forcing flowers for definite dates such as Christmas and Easter, and in reducing the time required for seedlings to grow large enough for transplanting.

No use of artificial light, in addition to that involving the eye, can be of greater benefit to humanity than this recently developed application to the stimulation of the growth and development of plants and vegetables, says Samuel G. Hibben, National Secretary of the Illumination Bureau of the Westinghouse Lamp Company, under whose direction the investigations were conducted. In a general way we have known that artificial light influences the growth and flowering of certain plants, but no well organized research work has been done until recently to prove whether the application of electric light was commercially feasible as a means of supplementing daylight. We now know that this stimulation of growth does not necessarily require the same intensity of light as daylight nor does it seem necessary to reproduce exactly the color qualities of daylight. We know furthermore that plants must rest, and that the application of artificial light is advisable only during carefully chosen hours when daylight is inadequate. Its use to impose a twenty-four-hour day upon the growing plant would be as disastrous as a similar effort in the case of human labor.

What this development means to the agriculturist is hard to predict. It seems, however, to promise a means of doubling the speed of development of many species, and bids fair to enable the horticulturist to bring his flowers into bloom at the time when their market is at its best. This has all been made possible by the perfection of flexible and cheap sources of light, and in it are contained advantages that seem as sweeping in their prospective benefits to humanity and as far reaching in their scope as anything that has happened since Luther Burbank developed the Shasta daisy or spineless cactus.

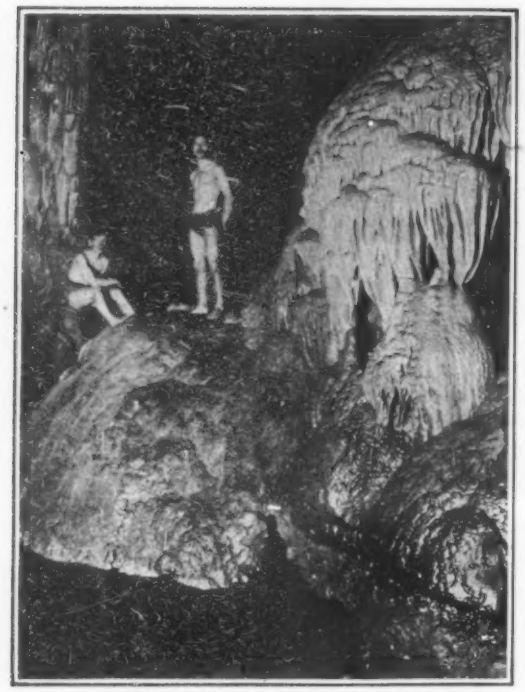


A battery of 500-watt electric lamps used to prolong daylight by artificial means and thus force plant growth

Animal Sculpture of 25,000 Years Ago

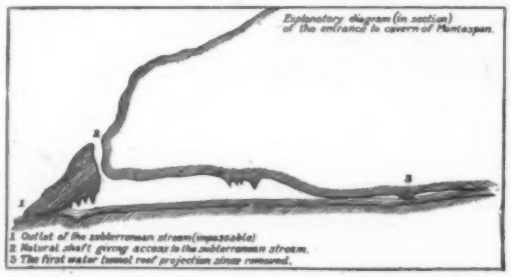
The Recent Discoveries in the Water-Blockaded French Cavern of Montespan

Photographs Copyright by *Illustrated London News*



Preparing for the plunge into the icy waters of the subterranean stream

ALMOST important discovery has recently been made in southern France, which shows that if in the Stone Age men were still ignorant of the art of making pottery by baking earth, they had at least discovered its plasticity and used it to model figures of animals, doubtless for purposes of magic. The story of the discovery reads like a fairy tale. A young French archæologist, M. Norbert Casteret, entered what appeared to be the mouth of a cave and swam alone through a subterranean stream 1300 yards long. He carried matches and a candle in a rubber case and by alternately diving and swimming he reached a great 220-yard gallery in the heart of a hill containing numerous works of prehistoric art. The sculptures—figures of animals modeled in clay—included a bear, three tigers, three horses and 20 modelings of uncertain character. The rock engravings of animals, twenty-six in number, are possibly the first writing of the cave men.


Explanatory diagram (in section) of the entrance to cavern of Montespan.
1
2
3
1. Outlet of the subterranean stream (impassable)
2. Natural shaft giving access to the subterranean stream.
3 The first water tunnel roof projection since removed.

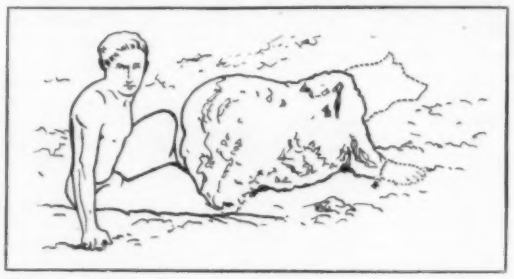
Montespan—The cavern's mouth and the subterranean stream

A more daring feat cannot be cited in all the annals of exploration. The discovery took place at Montespan in the Department of Haute Garonne, France. Work was at once carried on to reduce the water level so that access was rendered easier and our always progressive contemporary beyond the sea, *The Illustrated London News* dispatched a celebrated photographer, Mr. H. A. V. Coles, and we show the result of his labors through their courtesy.

Once through the ice water and truly in the bowels of the earth M. Casteret with his feeble candle, saw what had been closed to mortal vision for at least 25,000 years. On the rocky walls were seen engravings, made with flint implements, of prehistoric animals and others that have disappeared from France thousands of years ago—bison, wild horses, reindeer, stags, mules, wild goats, mammoths, hyenas, and so on. There were also visible, painted in red ochre, mysterious signs which represent perhaps the earliest writing of the cave men.

Lastly—and most interesting of all—there were found statues in clay, also representing animals. Hitherto, only one discovery of prehistoric sculpture had been made in the whole world. That was in 1912, when Count Begouen, of Toulouse, found in the Tuc d'Audoubert cave, in Ariege, two admirable clay figures representing bisons. His remarkable discovery caused a great sensation, and brought to light one of the finest known specimens of prehistoric art. The bisons of the Tuc d'Audoubert are the work of the Magdalenians, and go back in date some 15,000 years. The clay figures of the Montespan cavern are larger and in a rougher style and are unquestionably much earlier.

There is a bear (which we illustrate) lying down, about 3½ feet long and 2 feet high, in a natural attitude like that of the great Sphinx. The body is pitted with spear-thrusts and covered with layers of lime accretions, while on the left side is engraved a design too faint to be determined. The head never existed—or, rather, it was replaced by the skull of a bear cub, which had broken away and still lay between the forefeet.



Sketch of bear showing where the head was replaced by the skull of a bear cub. Detail of picture below

On the ground round the bear could be distinguished some 20 smaller models in bas-relief, rendered unrecognizable by the action of dripping water. Only three horses are well preserved, and suggest that the other figures were also horses. The three that have survived differ notably from our modern horses, having a very large belly, with abundant mane and beard. Elsewhere were three large figures of tigers, affixed to the wall, much damaged and partly fallen away by their own weight. They are each about five feet long and one bears on its breast the mark of numerous javelin blows. All these sculptures are authenticated by layers of stalagmite deposited on them by oozing water. The strangest part of it all is that all the animals had apparently been mutilated, especially in the vital parts, by somebody contemporary with the artist who modeled them. This confirms the theory that these caves with models or paintings of animals were primitive witch-doctors' caves. They are all placed in very inaccessible spots, and the animals modeled or depicted are always wounded by axes or arrows. Just like the redskins or the African tribes, these people, who lived 25,000 years ago, must have practiced the use of magic. We can imagine these men in their dark caves, black with soot from their reindeer-oil lamps, and clad in skins. On the eve of a hunting expedition they gathered round the priests of the tribe, and there stabbed and maimed the animals they feared, or those they wished to catch.

On a bank of clay, where there are some clay balls molded by primitive man, is also modeled half of a woman's body. Apart from the mural engravings and the sculptures, this gallery, which is very clayey, is covered with traces of fingers and innumerable patterns. One can see also the places from which the prehistoric folk removed clay for the making of figures. The hollows from which the clay was extracted are very distinct, and bear marks of flint implements. Some of these flints are still lying there where they were put down or mislaid. The walls of earth or rock likewise show traces of the scratchings of the cave bear, which also haunted this vast cavern at a time when access to it was probably easier than it is today, either because there was no water in it, or because there existed another entrance which is now stopped up.

A study of the sculptures in the Montespan cave points to their being the work of Aurignacians, who lived 25,000 years ago, and sought the most inaccessible caverns to devote themselves to their mysterious ceremonies. The javelin marks on the clay animal figures in the cave suggest that, like certain living tribes today, the first inhabitants of this cave used to gather round the statues they had fashioned, and practice rites of sorcery and propitiatory magic to secure good fortune in their future hunting. In every way M. Norbert Casteret's discovery, while rewarding him for several years of toilsome and dangerous research, throws a flood of light on the mentality, manners, and occupations of primitive man. It is a priceless contribution of our knowledge of the origin and history of mankind.

Prehistoric sculpture of a bear with M. Casteret alongside

The Size of the Universe

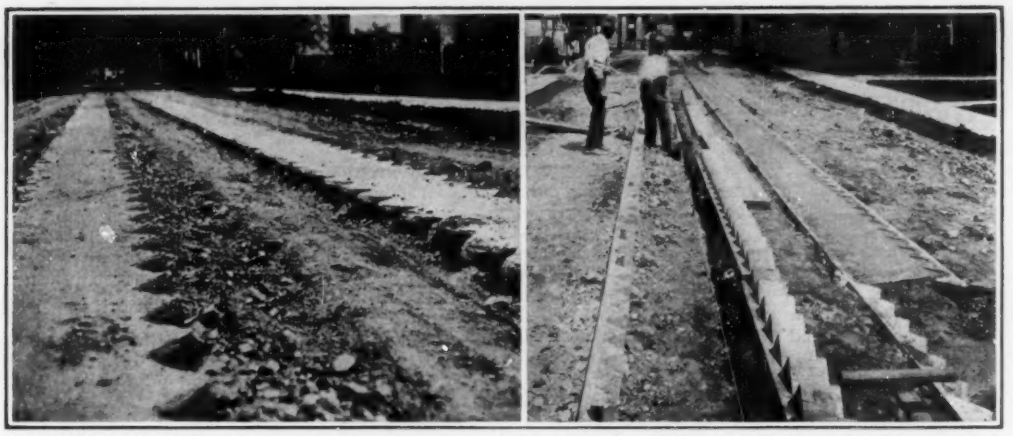
IN an unusually interesting article in *Science* for September 7th, Professor Archibald Henderson discusses the question of the size of the universe, according to Einstein's general relativity theory. The volume of this universe, expressed in grams, is seven followed by forty-one ciphers, divided by the mean density of matter to the 3/2 power; and the mass of this universe is seven followed by forty-one ciphers divided by the square-root of the mean density. If we assume that the average density of the matter in the universe is the same as that of the Milky Way, we find that the radius of the universe is at least 150 million light-years; or, since the distance from the earth to the sun is 93,000,000 miles, the radius of the universe is one million times ten million times the distance from the earth to the sun. Choosing the Milky Way as a "yardstick" of 30,000 light-years, according to the figure of Curtis, it will take 10,000 Milky Ways, laid end to end, to arrive at the diameter of the universe. Using the diameter of the earth's orbit as a measuring rod, we shall need ten trillions of these units to take the measure of the diameter of the universe.

The weight of the universe, in grams, would be one followed by fifty-four ciphers—which would carry us into the nonillions of grams. The weight of the Einstein universe bears the same relation to the weight of the whole earth as the latter bears to a kilogram. The weight of the earth to that of the sun is as one to 324,000. Hence we should have to take a trillion suns to get the weight of the universe.

It would take a ray of light, traveling at the rate of 186,000 miles per second, one billion years to go around the universe. To go around the universe it would take the fastest airplane three quadrillion years; the fastest automobile five and one-half quadrillion years; and an express train, traveling at the rate of sixty miles an hour, eleven quadrillion years.

The Twin Trails Highway

BY substituting for a full width highway, two relatively narrow strips of concrete, Mr. Robert Greene, an inventor of London, Canada, has created a new type of highway that has most of the advantages which a wide pavement possesses, and many good features which it does not possess. The strips of concrete, which are ordinarily from 18 to 24 inches in width each, are built between forms having a serrated edge. These wooden forms are constructed of two-by-eight inch plank to which are attached a series of triangular blocks cut from sections of six-by-six timber split cornerwise. When placed in a trench of suitable dimensions, with the serrated edges facing inward, the forms are ready to pour.



Left: **The twin trails of concrete after removal of the forms but before the highway has been graded to a level with their surface.** *Right:* **Laying the twin trails. Jagged forms of wood are used in order to give the serrated edge to the rails**

The twin trails type of road is suitable for any highway where the great percentage of the travel is straightaway, and it is designed to use as many as four pairs of trails on roads leaving large cities where the traffic is exceptionally heavy. Another manner of using the twin trails in locations where there is heavy traffic on country roads, is to provide a pair on either side of a 40-foot road with 20 feet of gravel road in the center.

In farming communities, especially if they are in hilly parts of the country, it is the experience of the farmer who brings a horse-drawn load of produce to a shipping point, that it is almost impossible for the horse to get traction on the slippery pavements that have been developed as a result of the growth of the motor vehicle. The Twin Trails road, however, may have a filling of gravel, or even of earth, permitting good traction for the horseshoe. One difficulty that is sometimes had by the motorist is to remount the pavement after having turned out, owing to a tendency for surface water to run along its edge and cut a small ditch. The Twin trails pavement, according to the claims of its inventor, does not develop this little rut, while the outline of the trails permits the wheel of the car to mount it without danger of skidding. There have been numerous attempts made to substitute something in the way of a rail or track effect for the full-width pavement; but none of the previous suggestions have impressed us as practicable. Mr. Greene's idea seems far more likely to succeed than anything of the sort that has gone before.

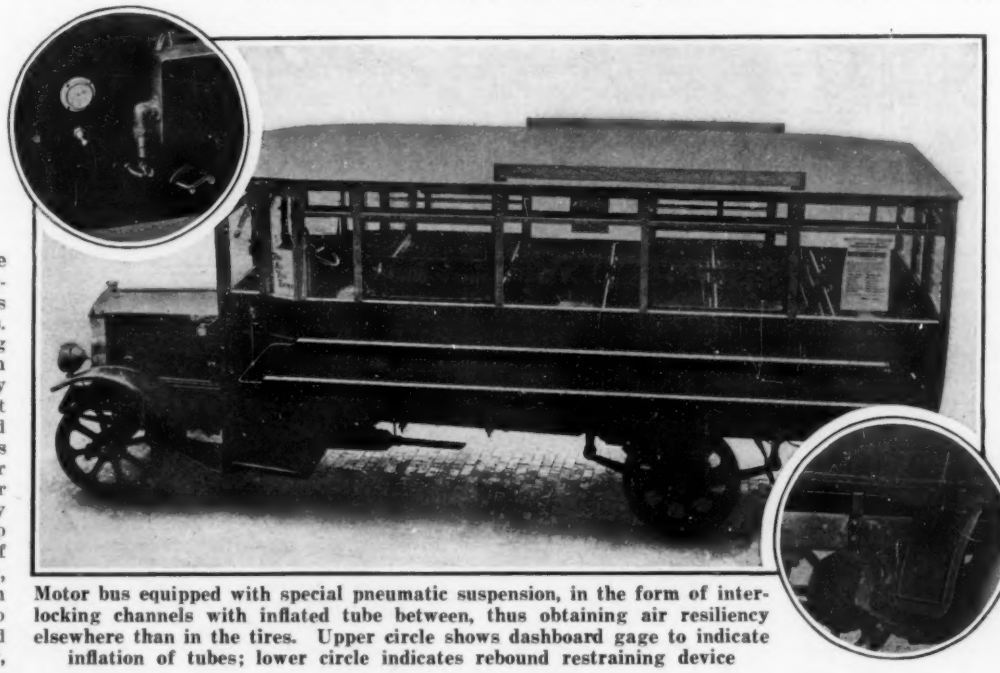
Suspending the Motor Car Body on Air

IN England, a new type of air suspension of motor car bodies is being used, wherein the body floats on a peculiar type of encased rubber tubing in such a manner that it acts much the same as pneumatic tires. This permits of giving the car the same resilience afforded by the pneumatic tire, while at the same time the wheels themselves are shod with the less expensive hard rubber tires. As shown in the accompanying illustration, the air suspension apparatus consists essentially of a modified inner tube built in a long straight form instead of in a circle. This tube is placed in a steel channel over which another slightly wider steel channel is rather loosely fitted, permitting the desired up and down springing motion of the body of the car. In short, the car body actually floats on air. The channels are bolted to the chassis side members and to the under side of the body, respectively. The air tube is of circular cross-section externally, but the upper or load-carrying portion is somewhat thicker, the thickness of the tube varying from three-thirty-seconds of an inch to one-quarter inch. Either end of the tube is closed and the forward end is fitted with a union and pipe connecting with a valve and pressure gage on the dash. Very low pressures are used on this new type of suspension, which is known as the Holden suspension, the pressures varying somewhat with the loads to be carried in the vehicle. In order to prevent the nested channels from separating with the upward movement of the motor body as the vehicle passes road obstructions there is a restraining device which limits the amount of vertical movement to three-eighths of an inch.

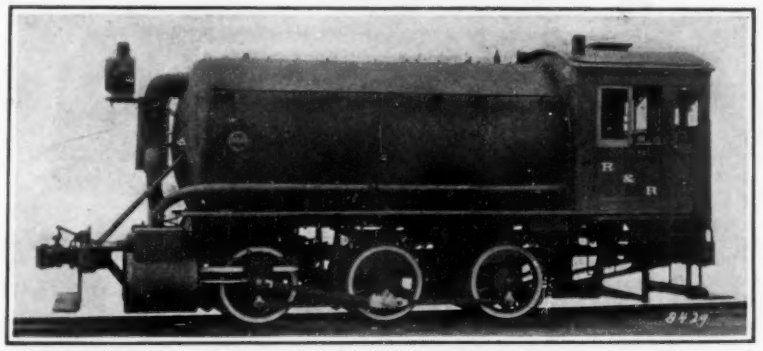
Tests which were made on the new air suspension gave remarkable results. A bus was used in these tests and this bus, loaded with only four persons and the driver, was driven over the rough pavements of Manchester. Each of the two suspension tubes was coupled to its own separate valve and gage, although, as illustrated, the two may be joined and treated as a unit. The pressures used were only five pounds to the square inch with the bus standing. When in motion, of course, the pressure oscillates wildly. As a test of the air suspension it was found easy to write a legible hand while covering the pavement in the air suspended bus, but similar tests made on ordinary municipal buses proved that this was impossible — as almost any reader would be prepared to grant without argument.

The same type of suspension has been used on street cars with 3½-inch tubes under 10-pound pressure, the whole giving a resistance to load of over 20 tons.

The wear on the inner tube is practically negligible, especially as the pressure under which it works is reduced by nine-tenths, as compared with the working pressures of the tubes in the ordinary tires. Apparently it is not even necessary to encase these springing tubes in an outer shoe to get proper life.



Motor bus equipped with special pneumatic suspension, in the form of interlocking channels with inflated tube between, thus obtaining air resiliency elsewhere than in the tires. Upper circle shows dashboard gage to indicate inflation of tubes; lower circle indicates rebound restraining device



Special steam accumulator engine devoid of smoke, gases or ashes. The usual boiler is replaced by a tank in which steam is stored for subsequent use

Driving Locomotives with a Charge of Steam

USING a mass of hot water for the storage of steam in the form of heat, is the basis of a steam accumulator which is being employed both here and abroad in a variety of ways. More recently, this principle has been successfully applied by the Baldwin Locomotive Works to a number of locomotives in order to meet special operating conditions. This type of locomotive is shown in the accompanying illustration. Where smoke or gases are objectionable and electrification is unwarranted, these locomotives fill a need. The reservoir is filled about two-thirds full of water. The water is then heated from a stationary boiler to a pressure equivalent to 200 pounds per square inch. A reducing valve delivers steam to the cylinders at approximately 50 pounds pressure. As the steam is drawn off, the heat stored in the water causes further evaporation and in part replenishes the steam supply. The charge of steam or heat will usually last from three to four hours, when it is again necessary to recharge the reservoir from the stationary plant. It might seem that this system would suffer unduly from heat losses, but it is, of course, a simple matter to give the reservoir the necessary insulation.

Head-Hunting in Papua

IN a recent issue of *Man*, Mr. E. B. Riley gives an account of the method of preparing the heads of enemies practiced at the village of Dorro in Papua. After the flesh and brains are removed a piece of rattan cane is fixed to the bottom of the mummified skull to take the place of the lower jaw and to act as a support for the packing of the neck. It was difficult to ascertain why the lower jaw is not replaced. The explanation seems to be that they prefer to hang this up in the house, and keep it as a mark or token of the owner's prowess in war, after the mummified head has decayed; but the lower jaw is sometimes replaced, being tied to the zygomas, as with the rattan cane. Finally, the head is dried, being fixed on a wooden framework over a fire lighted for that purpose, and the hair is pulled out as decomposition of the skin advances.

High Explosives that Will Not Freeze

Cold-Proof Powders that Eliminate the Dangers of Thawing Dynamite

WHEN Ascanio Sobrero, an Italian chemist, discovered nitroglycerin in 1846 he gave to the world the basis for high explosives. Although gun-cotton had been prepared prior to this, neither gun-cotton nor nitroglycerin were of any commercial value on account of being very unstable. About 15 years later, Alfred Nobel, a Swedish engineer, mixed nitroglycerin with "kieselguhr," an infusorial silicious earth formed from the minute fossil remains of animalculæ, and produced dynamite which was more stable than nitroglycerin but which still possessed the property of becoming chilled or frozen at comparatively high temperatures, around 50 degrees Fahrenheit. When in this condition nitroglycerin dynamite will not explode completely if at all.

Natural silicas, such as randanite, and chemically prepared amorphous silicas have been used as substitutes for kieselguhr but with no greater advantage.

Ordinary black blasting powder was tried as an absorbent in place of kieselguhr and it was found to greatly increase the strength, in fact the strength of the mixture was found to be greater than the sum of the strengths of the nitroglycerin and black powder when fired separately.

Black blasting powder was formerly composed of approximately 10 per cent sulfur, 15 per cent charcoal and 75 per cent nitrate of potash. The sulfur which is used to lower the ignition point of black powder has no value as an absorbent of nitroglycerin, therefore it was eliminated leaving charcoal and nitrate of potash. Nitrate of soda, which is far more abundant and less expensive than nitrate of potash was substituted for the latter because, as an oxygen carrier it was equally as efficient. This left the charcoal as an absorbent. Wood pulp or wood meal was found to be a better absorbent of nitroglycerin than charcoal, and as it was just as good a combustible, it was substituted for the charcoal. Through this evolution we have the modern so-called "straight" dynamite: nitroglycerin, wood meal and nitrate of soda. In the United States the first dynamite manufactured was in 1866 in California by the Giant Powder Company.

While these changes produced a stronger and more efficient dynamite than the former "guhr dynamite," yet it did not lower the freezing point, which was still a serious handicap for some uses. Modern chemistry was here brought into play and explosive products from nitrated petroleum and coal-tar derivatives such as TNT, nitrobenzol, picric acid and others were substituted for part of the nitroglycerin ingredient. This tended to lower the freezing point to a degree approximating that at which water freezes. Thus we have the L. F. or low freezing dynamites. Low freezing dynamites will often stand long initial exposure to temperatures below the freezing point of water, and short exposures to temperatures much below this without freezing but when once frozen and thawed they again freeze much more readily.

Further chemical research developed high explosives which did not freeze at any temperature no matter how low.

Chlorate of potash explosives are manufactured to a very limited extent, as their production is extremely dangerous, and nearly every company attempting their manufacture has met with a serious explosion sooner or later, accompanied by the loss of life. Paradoxical as it may seem, these mixtures are called "Safety Explosives." Chlorate of potash, which is one of the ingredients in fulminate of mercury detonating caps, is so extremely sensitive to heat, friction and impact when mixed with other combustibles, that its use as a commercial explosive is attended with considerable danger.

On account of the absence of nitroglycerin, non-freezing explosives do not produce what is known as a "powder headache." This is a characteristic which is second in importance only to their non-freezing qualities. While a powder headache is by no means a serious matter, it oftentimes produces so much inconvenience among workmen who handle dynamite that non-freezing powder is selected solely for its non-headache properties. To one extremely susceptible to the effects of nitroglycerin, merely shaking hands with a person who has been handling ordinary dynamite will produce a violent headache.

The thawing of dynamite is usually attended with more or less danger, owing to the unstable condition of crystallized nitroglycerin when frozen. Investigations have shown that the greatest percentage of accidents from handling explosives is due to thawing methods. In mines, accidents from thawing dynamite have been reduced to a minimum, due to the work of the United States Bureau of Mines in their investigations and recommendations for best thawing methods, and also the strict Federal and State supervision and inspection in all phases of the mining industry. But, in other operations such as quarrying, agriculture, road work, contracting and miscellaneous blasting, accidents from thawing are quite frequent. The New York Industrial Code, for example, states in the Rules and Regulations, "No blaster shall attempt to use any dynamite that is frozen," also "Only approved methods of thawing shall be permitted." The "permissible" explosives, so called on account of having been tested and approved by the Bureau of Mines for use in gaseous and dusty mines, automatically cease to be permissible when they are frozen. In Alaska the law requires that a suitable house in which to thaw explosives shall be built separate from the other mine buildings and shall be equipped with suitable apparatus for thawing explosives.

When the proper thawing methods, recommended by the powder manufacturers and the Bureau of Mines, are used, the danger is reduced to a minimum, but as carelessness increases the danger also increases by the *n*th power. At its best, thawing is an expensive, tedious, troublesome, time consuming and dangerous operation, all of which have been overcome in non-freezing high explosives. In extremely cold weather a non-freezing powder only should be used. It should also be used in moderately cold weather where thawing conditions are not possible or practical.

Using dynamite under conditions where non-freezing characteristics are valuable

ORDINARY dynamite freezes at about 50° Fahrenheit; special low-freezing varieties of this standard explosive remain unfrozen down to about 32°, the freezing point of water. Much work is done with explosives in climates where the normal temperature for long periods is far below these limits; and in such climates, the thawing of dynamite is a familiar and very hazardous pre-requisite of its use. This article describes the progress in the development of dynamites which remain unfrozen at all temperatures to which it is humanly possible for the weather to descend.—THE EDITOR.

Non-freezing powders are not as water resistant as straight nitroglycerin dynamites or gelatin dynamites and for that reason should not be used under water. The heavy paraffin paper shell of each cartridge protects the powder from absorbing moisture in damp or wet bore-holes. If conditions of moisture are not too severe the paper shell may be slit to facilitate better packing.

The velocity of detonation, that is, the quickness with which the chemical reaction takes place, ranges from 9500 to 12,400 feet per second. This is quicker than gelatin dynamite but not as quick as straight nitroglycerin dynamite.

The inflammability or ease with which non-freezing powder is ignited and burns ranges about the same as straight nitroglycerin dynamites. It is more inflammable than ammonia or gelatin dynamites.

Non-freezing powder is extensively used for quarrying, stripping, mining ore, clay and shale blasting, agricultural blasting, blasting ice and for all blasting at very low temperatures. In agricultural work it is not suitable for blasting ditches by the transmitted method. It is particularly adapted to quarry work where well drill holes are used.

The strengths in which non-freezing dynamites are regularly manufactured range from 30 to 75 per cent. They are packed in various size cartridges, the standard sizes being 1¼ inches in diameter by 8 inches long and 4 inches and 5 inches in diameter in lengths of 8, 10, 12, 14 and 16 inches. In the 1¼ x 8-inch size of cartridge, which is the size generally used, there are between 225 and 250 cartridges per 100 pounds.

London Fogs

THERE is no fundamental difference between mist and fog: in most cases fog is only a dense mist, and the density at which mist becomes fog is a matter of definition. When mist and fog are formed in fairly clear air they are white. On the other hand, if the air contains a large quantity of impurities, such as carbon particles from imperfect combustion, the mist particles absorb the impurities and become themselves dark-colored. In this way are formed those dense fogs in London which are likened to pea soup. It was originally thought that the density of a London fog was due to the fact that the smoke of the city provided an unusually large number of nuclei on which condensation could take place, thus offering a temptation to the air to deposit its moisture which it could not resist. As a matter of fact, there are always sufficient nuclei in the purest air in England to allow of the formation of fog whenever the meteorological conditions are suitable.

The relationship between smoke and fog is peculiar, and may be said to be accidental. The meteorological conditions which are necessary for the formation of fog are such that while they last smoke cannot get away either vertically or horizontally from the place of its origin. Above the fog there is a temperature inversion which effectively prevents all upward motion of either air or smoke, while fogs over the land usually form in calm air. Thus during a fog practically all the smoke which London makes is kept over it and remains within a few hundred feet of the ground.

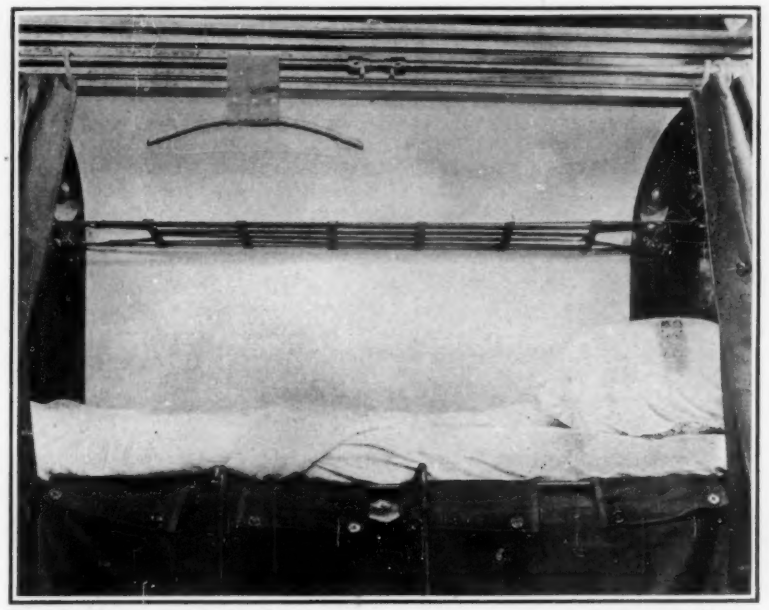
This smoke, combined with the deposited water, can, as we all know, produce such an obscurity that midday is as dark as midnight. The total abolition of smoke from London would not reduce the occasions on which mist and fog occur, but many fogs would remain mists, and we should never have a "London particular." For the formation of mist and fog it is necessary that the temperature of the air should continue to fall after the dew point of the air has been reached.

The extent to which the temperature continues to fall below the original dew point determines the density of the obscurity, neglecting for the moment the effect of impurities. This cooling can be brought about in several ways, of which only two are of real importance in this connection.

Fogs may be caused by warm air blowing over a cold sea or a cold land surface. The fogs of London are, however, almost entirely due to the loss of heat from the lower layers of the atmosphere into a clear sky above. The air radiates its heat, its temperature falls and condensation takes place as already described. Other methods of fog formation, such as the mixing of warm and cold air, are of secondary importance and never give rise to more than patchy local mists or light fogs.—*Abstract from Nature*, April 14, 1923.

Exit the Pullman Car Hammock

THE fishnet hammock, subject of an old joke which the writer will forego, is destined to disappear. It provided a place for the clothing but assured the clothing of an early trip to the presser, for nothing under the sun could have been more efficient in the work of putting wrinkles in the wrong place than this so-called convenience with which the American people have put up for decades. The Pullman Company is now equipping its new cars with a rack designed to occupy the same position above the berth as did the hammock, but having the advantages of holding the trousers flat and of providing a place for the hand baggage. This new rack is made in skeleton form of one-inch green belting, and is fastened to either end of the berth by means of hooks. These hooks slide on iron brackets so that the whole rack folds back flat, either when it is not desired by the passenger or when the berth is made up for the day. This rack will be appreciated by travelers who have wished to retain hand baggage in their berths but who have found it necessary to find a place for it to lie where they prefer to be lying themselves.



New Pullman car clothing rack which provides a place for luggage and permits the clothing to be laid out flat

Stage Scenery on the Building Block Principle

ALTHOUGH it was generally believed that the limit of novelty in stage setting and scenery had been reached, such has recently been proved not to be the case, for the third production at the Earl Carroll Theatre in New York City has witnessed the introduction by Mr. Carroll of an original and simplified method of building up scenes that bids fair to be of great usefulness, especially on rather small stages.

Heretofore, when raised platforms and steps were required, these were specially built. They invariably occupied a great deal of space, and could only be used on an extended scale in such places as the New York Hippodrome, where there was ample room to store them when not in use. Some of the most effective scenes at this giant playhouse were obtained by long and wide flights of stairs down which row upon row of girls marched out of sight beneath the waters of the tank.

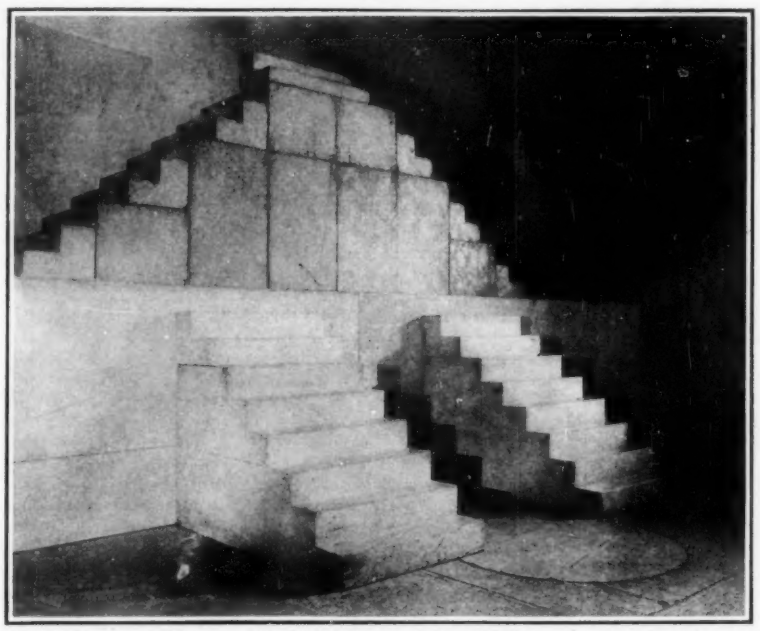
In producing his latest offering, Mr. Earl Carroll determined to make use of these staircase effects if possible. Heretofore, staircases had been built up in two sections and separated for storage, while platforms were elaborate affairs (sections of the stage) that required hydraulic elevators to raise them into place. Needless to say, the expense and cumbersomeness would preclude their use in a small theatre, the latter particularly in a revue with many scenes. To get around the difficulty, Mr. Carroll invented a system of unit building block construction whereby he could build a long, wide flight of stairs in a limited space, as well as any number of raised platforms of any shapes which might be desired.

After working out his problem on a small scale with a tiny model, Mr. Carroll proceeded to construct the actual settings for the stage of his theater. In doing this he followed the model precisely to scale.

As will be noted in the accompanying view, large units are shown horizontally, with stairs leading up to them, and with other stairs leading up from each side to the apex. These stairs are all constructed in units of two steps each, assembled upon different sized blocks whose corners form intermediate steps. Any scene whatsoever can be quickly and easily built up by but four stage hands, since the different sized units consist of light frames covered with three-ply veneer. For transportation purposes all units except the smallest can be knocked down flat, while these non-collapsible two-step units can be placed in interlocked arrangement, forming a block. In order to get a long flight of steps in the limited space of about thirty feet, the steps were made with but a ten-inch tread. This is not exactly a sumptuous stair, but is sufficient for all purposes.

The tread and height of the steps play an important part in obtaining the proper lighting effects. In the present instance much thought has been put upon securing the lighting that will properly display the figures and costumes. On each side of a secondary proscenium is a vertical row of spotlights, while colored and white lights in the flies and in the "canopy" in front of the stage, as well as below the balcony railing (called "face" lights) properly light the actors and do away with shadows. There are also the usual spotlights in the cinematograph booth at the rear of the balcony. All these lights must be carefully calculated to meet the stair dimensions.

Mr. Earl Carroll's unit block system of ground stage scenery construction or setting, is adapted to many forms of scenery, as the blocks may be covered or masked with painted scenery wherever desired. The blocks are all painted a light blue and sprayed with silver. Italian blue was found by experiment to be the proper color to tint the back wall of the theater which represents the sky and forms a suitable background for any scene. The invention is a decidedly novel and useful one.



Stage scenery made up of light blocks or units which can be arranged in any desired manner and knocked down for storage and transportation

Recent Aeronautic Investigations

FEW industries offer better illustrations than the manufacture of airplanes of the intimate relation between purely scientific investigations and the practical application of the results. As an example of this fact, attention may be directed to three experimental researches in progress at the laboratories and flying-station of the National Advisory Committee for Aeronautics at Langley Field, Virginia.

The first research deals with the pressure distribution over the wings, tail surfaces, etc., of an airplane. What is novel in the present investigation is the extension of the problem to airplanes making maneuvers, and to wings of different plan form, varying the angle of attack and the aileron angle. The method adopted is simple: numerous series of small openings are made in the surface to be investigated; each of these is joined by a rubber tube to a capsule containing a metal diaphragm, to which is attached a tilting mirror; a beam of light is reflected from this on to a photographic film which may be shifted, thus permitting a series of observations to be made. The apparatus in use records the pressures existing at 60 points simultaneously.

Among the questions already investigated are: the change in pressure distribution produced by a loop, a roll, etc.; the effect of the shape of the wing-tip, square corners, elliptical, raked off, etc.; the influence of the airstream from the propeller. From the knowledge thus obtained, the airplane engineer can decide upon the best shape of wing or elevator, etc., and upon the relative strength required in a different part of his structure.

The second research was undertaken to learn the actual motion of an airplane in alighting, taking off, making oscillations, and maneuvering, and at the same time to record the motions of the control surfaces and the forces exerted by the pilot. A large number of instruments is required, all of which were newly designed with special reference to lightness and compactness, as well as to accuracy. The central instrument is a photographic film wrapped on a cylinder which is in rotation, for all records are made upon this by beams of light reflected from mirrors which form part of all the various instruments. When in actual use on an airplane, the pilot simply presses one button at the beginning of a maneuver, and this starts everything. The instruments in use at the present time are as follows: (a) chronometer, (b) airspeed recorder, (c) single component accelerometer, (d) three-component accelerometer, a combination of three of the previous instruments, (e) angular velocity recorder, making use of a high-speed electric motor as a gyroscope, (f) three-component angular velocity recorder, a combination of three of the previous instruments, (g) control position recorder, (h) force recorder.

From a practical point of view these instruments allow the performance of an airplane to be recorded accurately, in a manner quite free from the personal impressions of the test-pilots, and, further, the records taken in any maneuver tell a story which is perfectly plain.

Einstein and the Recent Eclipse

A WRITER in *Nature* for April 21, says that the two sets of results of the expeditions, one from Canada and the other from the Lick Observatory to Wallal, Western Australia, for the solar eclipse of last September, have now come to hand, and that both report in favor of the Einstein shift of starlight. In each case the number of stars measured was very large—exceeding 80—the magnitudes being between the seventh and the tenth. From this it is evident that the exposures were comparatively long, and that consequently there would be considerable extension of the corona on the plates, which would obliterate the stars nearest the sun. The measures, however, were sufficiently exact to give a decisive result, using the more distant stars. Professors Campbell and Trumpler measured all their plates in duplicate; the values for the shift at the limb of the sun deduced from the individual plates ranged from 1.59 inches to 1.86 inches, the mean of all being 1.74 inches, which is only 0.01 inch less than Einstein's predicted value.

As Professor Campbell is well known to have been in no sense predisposed in favor of Einstein's theory, this result, combined with that of Professor Chant and the mean of the Principal and Sobral results in the 1919 eclipse, will probably be regarded as setting the question at rest.

One Law Versus Forty-Eight

The Practicability and the Necessity of Uniform Motor-Vehicle Legislation in All the States

By the SCIENTIFIC AMERICAN *Staff*

WHEN one enters Connecticut over any major highway, one meets a signboard that may not be quite as big as the proverbial house, but that looks much bigger when first it bursts upon the eye. "You are entering Connecticut," says the sign; and it proceeds to catalog the major points of the Nutmeg State traffic law. Speed limits, regulations for passing trolleys, the sort of locality that defines the zones in which slower speed is exacted—all important points on which Connecticut rules do or may differ from those of other States, are here epitomized for the benefit of visiting and homecoming motorists. Other States employ the same idea; we mention Connecticut merely because it is the most familiar example of those which we might cite.

Pennsylvania practice typifies another way in which it is possible to aid drivers from across the State line in their contact with the law, while at the same time making it vastly easier for home motorists to conduct themselves according to the proprieties. In this State there is but one lower speed limit—fifteen miles per hour. It applies in all cities, towns, villages and crossroads aggregations of houses, regardless of whether the place be incorporated or whether the houses average 99 or 101 feet apart. It applies equally at points on the open road made dangerous by rail or road crossings, curves, grades, etc. Wherever it applies, the law instructs the State Highway Commission to erect signs plainly warning the motorist of the restriction; and where the restricted zone runs through a village, or for any other reason is of considerable length, the law is equally mandatory that its termination as well as its beginning is indicated. One who drives in Pennsylvania comes to know and to watch for the welcome "End of Limit" sign which leaves him free from all doubt as to just where it is proper to resume speed.

Pennsylvania's procedure is ideal in more ways than one. Not alone is one advised of the location of restricted zones, and enabled to know with a minimum of effort what the restrictions are; one is beyond this assured that, in the absence of these signs, the State code applies. Local regulations conflicting with the State laws are explicitly barred; and the presence of the local rules in the State code makes this prohibition effective. But not everywhere is it thus. Of the 40 States for which information is on hand as we write, no less than 21 permit—sometimes in so many words and sometimes through failure to prohibit it—the setting up by local jurisdiction of speed limits and other traffic laws, without reference to the degree of contradiction which may exist between these and the State-wide code. Nor is it by any means the case that all such States require locally restricted areas to be posted.

Now, of course, we have with us always the good old Anglo-Saxon common law; so that, if you go into a strange State and set up ignorance of the statute as an excuse for its violation, the magistrate may very properly tell you that he isn't interested in your ignorance of the law. But as indicated in the previous article of this series, and by the very practices cited in the cases of Connecticut and Pennsylvania, we are today going through a process of quiet unwritten modification of this principle of law, which places upon the agencies of Government some degree of responsibility for broadcasting the provisions of our more complex enactments. This is the more so when, as with most of the traffic laws, the statute defines, not crime as against innocence, but conventional behavior as against mere unconventional acts which are not in themselves criminal. So if you plead ignorance of the traffic law, even in your home State, the magistrate is not likely to tell you that you are chargeable, willy-nilly, with knowledge thereof. What he *is* very likely to tell you, however, is that the State has gone to considerable expense to print, in convenient booklet form, all its laws governing motor vehicles; that this booklet has been available for your examination without cost or inconvenience to you; and that under these circumstances you are alone responsible for your own ignorance. Strictly speaking, of course, this is true. But a careful study of the little books in which the various States have put up their traffic laws for the use of the consumer leaves us quite cold over the practical possibilities of learning to drive legally and conventionally therefrom.

All these codes necessarily contain a lot of matter about licenses for home cars and home drivers. This section is of interest to the man who is buying or selling a car, and to the visitor who contemplates so long a stay that he may subject himself to the necessity of registering his car, himself, or both. But it has no bearing whatever upon the more urgent question of how to drive legally and safely.

What are the speed limits? Where do the lower limits apply? Does one give the right-of-way to the car on one's right, or does the State fail to prescribe a rule here? Does the car on the main road specifically have the right-of-way over one emerging from a private way, or does the State again leave this to the drivers to settle anew on each encounter? How shall one behave in the presence of a standing trolley? Are the headlights which you brought with you legal in this State? Will you be required to add a mirror, or some other article of equipment which is not demanded by your own State? Is the visibility of your rear license plate up to the mark, or must you purchase a new taillight assembly? May you, if the weather calls for them, mount tire chains once for all, or must you remove them when you come to a cleared paved road? Shall you dim for approaching traffic; or will this be regarded as admission that your bright lights are too bright, or will it be taken as driving without adequate light, or will your very ability to dim and brighten your lamps from the driver's seat be in itself a violation?

These and numerous other points will come specifically into the mind of every conscientious motorist every time he crosses a State line. Many of them will even bother the home driver to some extent, so that he must check up on them from time to time. In this situation, given physical possession of the official booklet of motor laws to start with, the next thought in any rational mind is of an index.

Well: of 40 motor-law pamphlets and booklets from 40 States, 20 have indices. Three others have running heads throughout the text, on a basis that makes them of material aid to the eye that is searching for the speed limit or the reciprocity period. The remaining 17 lack any pretense at index or other guide. Of these, one contains more than 16,000 words, according to our rather practiced calculation; and numerous others run above 10,000. Is it rational to ask the man who wants to know whether he may pass a standing street car to read through the equivalent of five to eight solid pages of the SCIENTIFIC AMERICAN in search of the information? We might answer with a categorical negative; but we will not be even so rash as this. We will say only that it depends upon the character of the text in question.

Some States have well-modified motor codes. Others—to put it mildly—haven't. There is every reason why the latter, rather than the former, should be the case. Sometimes the motor code consists of a series of isolated acts, passed from time to time when a gap in the existing laws became evident. When this is the case, these acts are usually arranged in chronological order of passage in the little booklet prepared for the public convenience. Indeed, how else can they be presented?

Other States, some ten years ago more or less, passed a general traffic act, designed to be a complete and self-contained whole. Maybe it was and maybe it wasn't, at the time; in either event, it is perfectly certain that it wasn't, now. Increasing traffic, changing conditions, changing outlook upon the questions of policy involved in automobile licensing and traffic regulation, have all forced frequent amendments and additions—the one idea that runs through the series being simply to keep the code up to date. The earlier and the simpler amendments can be, and often are, actually applied to the original text by the compositor, the wording of the law being changed as provided by the amendment, or the new clause being inserted at the point where it claims to belong. But usually the later amendments post-date the pamphlet itself, and are carried on pages inserted in the back, or even in separate leaflets. Moreover, in numerous cases the "amendment" is really a lengthy added section, of large and miscellaneous import, which at best can only be grafted on to the original act, at a point where its connection is not particularly obvious; and which at worst is published in a separate leaflet, with nothing in the original pamphlet to indicate that the act as there printed has been enlarged. Usually such a large modification of the traffic act as is contemplated by these remarks is given a separate legislative title as Chapter Umpty-Ump of the laws of Nineteen-Blankety-Blank; and it is then printed as such, with no attempt whatever to correlate it with the related matter in the original law.

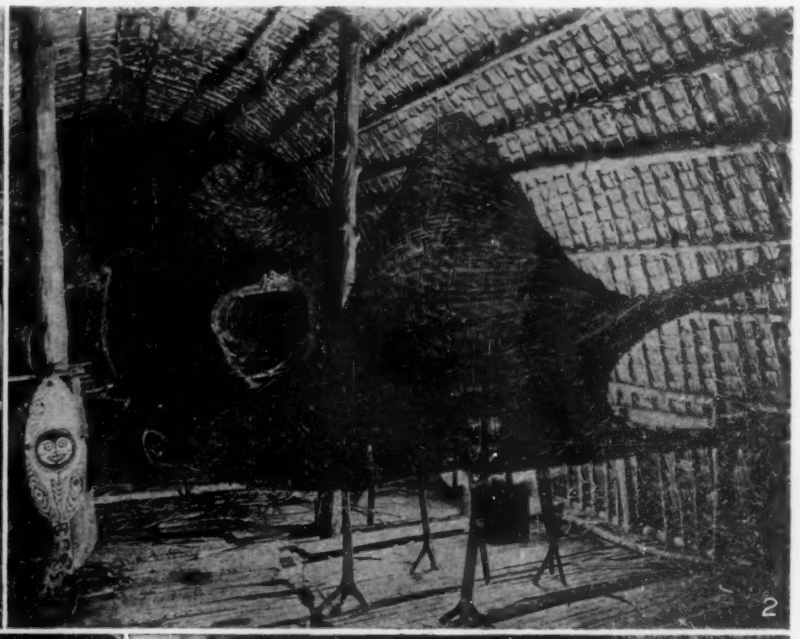
The result of all this is to make the printed pamphlet practically unusable in the absence of an index. This throws, or should throw, something like half the States out of court on the claim that they have put their traffic codes in the hands of the public. For we do not exaggerate when we say that in most of the unindexed pamphlets (and some of the indexed ones, for that matter), the only way to find a given item, be it speed laws, headlight provisions or what you will, is to read the text until you come to it. Even in doing this, there is a large hazard. It is a conscientious reader indeed who will take in every word, and not assume, after having read the opening portions of a paragraph on, say, the permissible weight of motor trucks, that it doesn't contain what he is looking for. In more than one instance we searched quite honestly, but using this technique, for a specific item, without success; only to run on it later in looking for something else. Driver's age-limits and reciprocity periods seem peculiarly prone to getting tucked away as a subsidiary clause of some section having no apparent connection with these points.

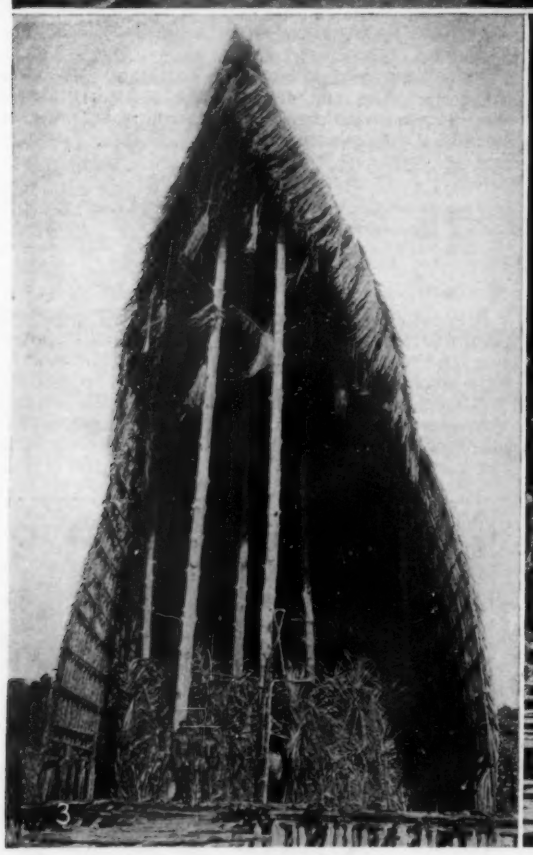
One or two crowning bits of stupidity demand special mention. Pennsylvania, as we have implied, is a model State in its motor administration; and its codified laws are admirably arranged—with no index, but with a very complete and effective series of running heads located in the extremely wide side-margins. This pamphlet lacks a title page, the text beginning right on what would be the front cover. In the brief title at the head of this page one fails to find the name of the State. One scans the preamble, the enacting clauses, etc., with the certainty that somewhere there must be reference to the legislature of the sovereign State of So-and-So. But no; so one turns to the last page—and again one is fooled. There is the Governor's signature, in facsimile, large as life; but even under it there is no line indicating of what State he is chief executive. It is a solemn and sacred fact that in this entire book, from first word to last, the name "Pennsylvania" does not once occur. The Act does not even carry a date-line from Harrisburg as an indirect clue. If you didn't know to what State Mr. Gifford Pinchot pertains, or if he chanced to have a trick signature that nobody could read, it would not be possible to identify this law as that of Pennsylvania.

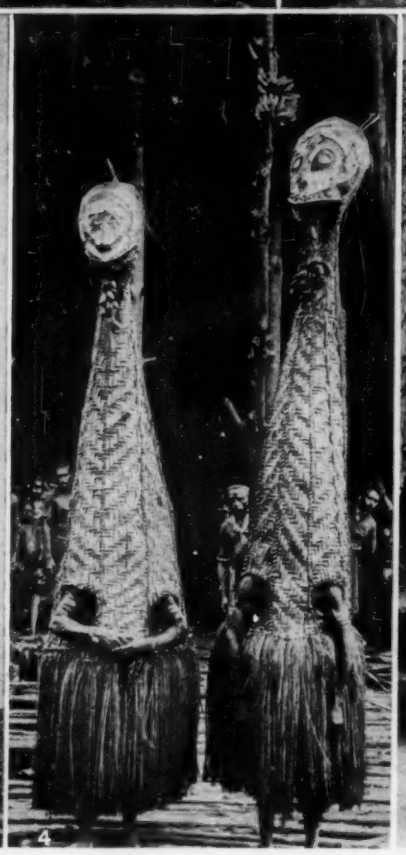
New Jersey has a marvelous Commissioner, so good that he has survived numerous changes of administra-

(*Continued on page 140*)

LAST month we carried the opening article of a series upon the legal and physical problems created by the growth of the automobile to its present place in the national life and the national consciousness. We gave an analysis, the burden of which was to show that the most immediate attention requires to be given the problem of making the motorist acquainted with the laws of his own state, and of the states through which he drives. This month we try to show that, so long as they remain in their present diverse and ill-digested condition, it is not going to be possible to do this effectively; and that therefore the necessary relief is to be found only in the direction of standardizing the laws of the individual states around a single formula applicable in all states. With the next article, in the March or another early number, we shall pass from destructive to constructive criticism, suggesting some of the means whereby uniformity may be attained, and some of the provisions which a uniform motor code proposed for adoption by all states should have.—THE EDITOR.



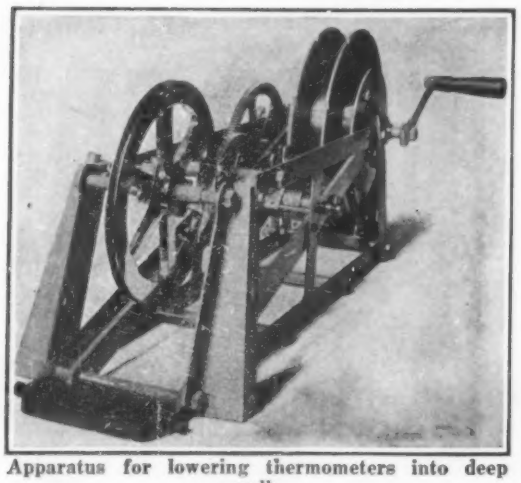




A RACE of head hunters with Jewish features has been discovered by Captain Frank Hurley, explorer, 250 miles up the Fly River, at Lake Murray, in the large island of Papua. The new race was discovered last February and called "Sambios," because of their habit of calling out "Sambio" and waving their paddles in friendly fashion on approach. This deception almost cost the lives of the explorer and the white men with him. They were lured into an ambush by the tribesmen on their first visit ashore, but escaped in a hail of poison arrows. Friendly relations were finally established by trading tin boxes and other empty metal containers for native products. The Sambios had never seen metal before and did all of their boiling in stone or bamboo, so that they ultimately accepted the explorers' friendship as of more lasting value than their heads.

Our views, taken from Captain Hurley's collection, are as follows: (1) The Motuan village of Elavala, which is built out in the water, off a small island. Doubtless the Motuans built their homes in this fashion to render them impregnable to attack from hostile land tribes. (2) At the remote end of the great Kau Ravi, which is shown in another view (3), are these grotesque objects called Kopiravi. These were held in great dread excepting by the ancient chiefs who were high priests. These objects, symbolizing crocodiles, were regarded as gods. Victims were placed in these Kopiravi, after having their arms and legs broken to prevent escape. The body the next morning was cut up and seasoned with cocoanut for boiling. (3) Entrance to the great Kau Ravi. This large structure functions as a parliament house, cathedral, museum and club-house. It is 75 feet high and 400 feet long. Only the warriors are permitted to enter, and death is the penalty for female transgressors. The interior is divided into dens in which are shrines containing the skulls of victims that have been killed and eaten. (4) The taboo goblins of Urma. The taboo goblins are regarded as sacred spirits. (5) Main street of Mailu village, southeast Papua. These remarkable people are a maritime race, carrying on their trading by sea. Their canoes are seafaring craft, capable of carrying up to fifteen tons. (Photos, Copyright, Captain Frank Hurley.)

SNAPSHOTS OF THE "SAMBIO" HEAD HUNTERS OF NEW GUINEA



Apparatus for lowering thermometers into deep wells

The Heat of the Earth

Apparatus with Which Deep Temperatures Are Determined

By Otto Wilson

IN THESE troubled times it takes a startling eruption of a Mt. Etna or a disastrous earthquake to remind us that we are living in a world unfinished physically as well as politically. What the swarming humans on the earth's surface would see if they could gaze a little way beneath their feet would give many of them a thrilling moment of surprise. We ordinarily carry around with us the idea that the earth is a great solid globe, probably rather hot in the interior. But if we should picture to ourselves a steel cannon ball, heated in an intense flame until it was far more than white hot and then sent whirling on its way covered only with the thinnest of thin films of chalky dust, we should probably have a much more accurate idea of what sort of home we inhabit. It is generally accepted that the earth's interior has a density as great as or greater than that of steel and a temperature which would not only melt but even vaporize most metallic elements there if it were not for the immense pressure which keeps them in solid form. The outside lithosphere or shell of rock is itself burning hot except at the very surface, and men have already penetrated to depths where the heat is almost that of boiling water.

Geothermic studies have been carried on in a more or less haphazard fashion for a good many years and a good deal of data has been accumulated. But it is only since the miners have eaten their way far down into the surface rocks and the oil-seekers have sent their drills still deeper that the problem of determining the earth's heat has become of practical as well as scientific interest. The Federal and State geologists have been busy in recent years in making observations and gathering data, and three years ago the U. S. Geological Survey published the first comprehensive account of geothermal conditions that has yet appeared. This survey includes for the most part the observations of geologists made in mines and wells, but many of the figures are admittedly of questionable significance as they were obtained from temperature-observations of flows of water whose depth of origin could not always be determined. A careful rechecking of all these data and the gathering of many new records not only for the United States but for all the rest of the world as well by Mr. C. E. Van Orstrand, of the U. S. Geological Survey, is now in progress.

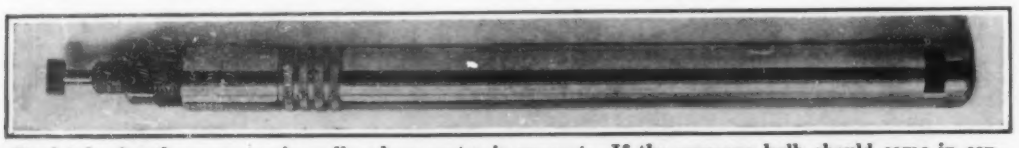
One fact is conclusively shown by these studies, and that is that the rate at which the temperature of the earth's crust increases with increasing depth varies widely for different parts of the earth. Some of these variations are obviously due to local causes. In the upper peninsula of Michigan, near the cold waters of Lake Superior, the deep copper mines of three to five thousand feet show temperatures at the bottom ranging from about 60 to 90 degrees Fahrenheit as compared with a mean annual surface temperature of 44 degrees. This is a rate of increase, in general, of one degree in 120 to 140 feet or more, whereas in central or southern Michigan the rate is one degree for differences in depth ranging from 40 to 90 feet. In a broad belt of territory in the West which includes western Washington, Montana, South Dakota, and Nebraska, the general region in which the hot springs and geysers are found, the earth becomes rapidly hotter with increasing depth. For the last two-named States the rate is about one degree Fahrenheit for each 20 to 40 feet of increased depth, and in Idaho, in regions of recent volcanic activity, observations of temperatures in wells have shown a rapid increase of about one degree for 10 to 20 feet. These local variations make it difficult to arrive at generalizations on the subject of the average rate of increase in temperature as we go deeper into the earth's crust, but it seems to be fairly well established that the rate is considerably less in the older rocks than in the newer formations.

The deepest hole which men have ever made in the earth was in West Virginia, where the Hope Natural Gas Company, under the direction of its vice-president, Mr. John B. Corrin, of Pittsburgh, set out to explore the lower strata in a search for deeper oil and gas sands than any that had yet been reached in the State. They sent their drill down to a depth of 7579 feet, or just 341 feet short of a mile and a half, when a cave-in effectually stopped further operations. While they did not reach their objective the venture bore much fruit of scientific interest in the shape of minute fossils and temperature readings. Mr. Van Orstrand, equipped with specially devised thermometers, made regular temperature tests every 100 feet down to 2000 feet and every 250 feet thereafter, which he found to agree in the main with the records which he had previously taken in the world's second deepest well, drilled by the same company in West Virginia in 1916-18. At a depth of 7500 feet, where the last temperature test was made, the thermometer registered 168.6 degrees Fahrenheit as compared with 53.3 degrees, the mean temperature at the surface. This is an average of 65 feet for each degree in increased temperature for the whole well, although the gain was not uniform all the way down. The rate in the second deepest well was about 70 feet, and others in West Virginia showed much the same temperature increase although in some of them as much as 80 or 90 feet of added depth was required to raise the temperature one degree. The following figures show how hot were the rocks at various levels and how steadily the temperature rose:

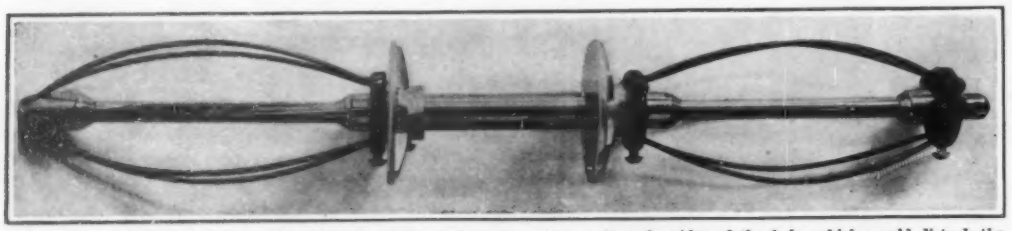
Depth	Deg. F.	Depth	Deg. F.
100 feet	53.7	4000 feet	104.7
500 feet	59.9	4500 feet	111.6
1000 feet	65.6	5000 feet	121.1
1500 feet	71.8	5500 feet	133.1
2000 feet	78.4	6000 feet	143.9
2500 feet	86.0	6500 feet	154.5
3000 feet	91.9	7000 feet	162.2
3500 feet	97.6	7500 feet	168.6

It is not altogether a simple matter to get these temperatures accurately when the depth reaches several thousand feet. Several different kinds of thermometers have been used, but for depths down to 3000 feet Mr. Van Orstrand has found that the electrical resistance thermometer is best for use in wells which are free from oil or water. For lowering this thermometer into the

(*Continued on page 143*)

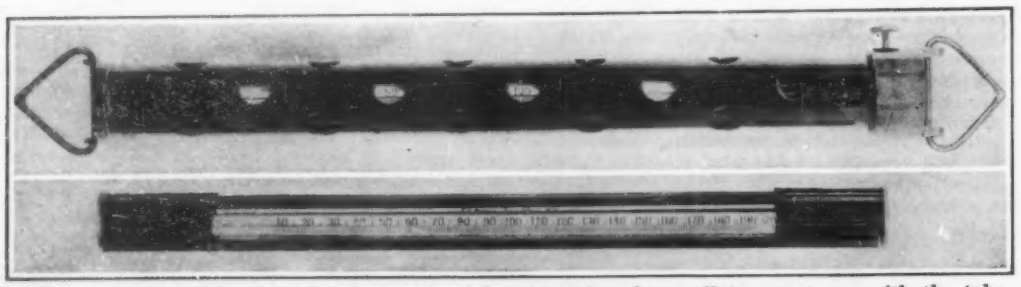


Steel tube for thermometer in wells where water is present. If the mercury bulb should come in contact with the water, the pressure would drive the fluid upward and the readings would be of no value

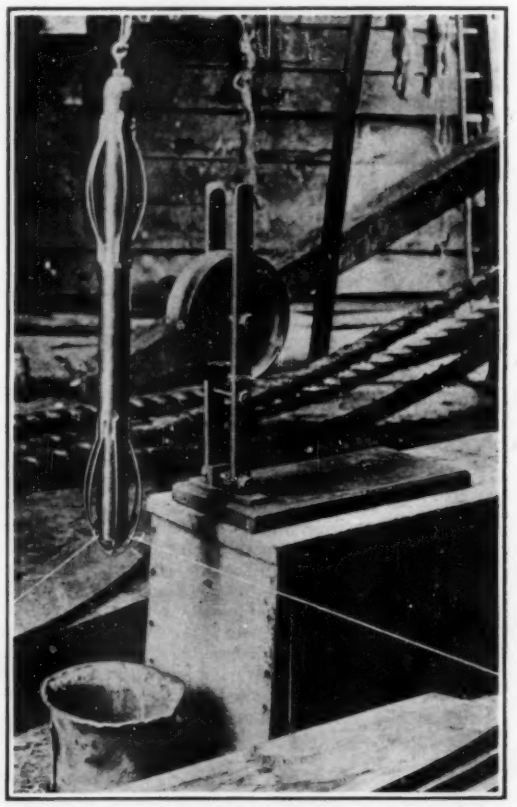


In the center is a plain brass rod. The wires keep it from swinging against the sides of the hole, which would disturb the mercury in the thermometers immediately above. The aluminum disks aid the operator to determine when the line has struck water

Weight attached to the end of the line used in lowering thermometers into deep wells



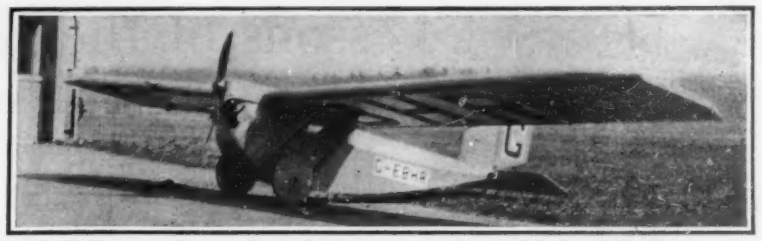
Maximum-recording mercury thermometer used for measuring deep-well temperatures, with the tube in which it is placed



The inconspicuous opening of the world's deepest well, with a thermometer waiting to be lowered in

Flivvers of the Air That Approach 100 Miles Per Gallon

THE recent competition for small motor-driven gliders or light airplanes at Lympne resulted in some wonderful performances, and definitely marks a new trend of design which must ultimately produce a type of aircraft which in its relation to ordinary aircraft will be analagous to the position of the cyclecar in the automobile world. The conditions of the competition limited the size of engine used to 750 c.c. capacity roughly equivalent to six horsepower, the chief prize being awarded to the machine accomplishing the greatest distance on one gallon of any standard fuel. Subsidiary prizes were awarded for speed, altitude and for greatest distance flown irrespective of fuel consumption. Although the possibility of flying with engines of very low power has been recognized for some considerable time, and especially so since the progress achieved in the design and use of gliders, there has always existed an impression that machines of this class would be extremely fair weather craft, demanding more rather than less skill in piloting. The outstanding feature of the Lympne competition was the excellent behavior of most of the machines in extremely bad weather, which gave no indication of lack of power or control. The course was 12½ miles in length and roughly triangular in shape, the latter circumstance definitely precluding the possibility of any assistance being rendered by favorable winds. Further, the term motor-glider which has been generally applied, has suggested that the flights of the machines would be in the nature of motor-assisted glides in which soaring against the rising current would play an important part. When it is considered, however, that the absence of any means of restarting after the engine had stopped in the air would necessitate its being kept running during the period of soaring, which would necessarily be at a slow rate of forward speed, it will be seen that this maneuver would detract from rather than add to the miles per gallon flown. Actually the machines flown at Lympne, as will be seen by the accompanying illustrations, were miniature airplanes possessing a remarkably high performance, and which moreover was not obtained at the expense of structural strength, most of the machines conforming to the regulations regarding factors of safety, etc. The machines accomplishing the greatest distance per gallon of fuel were the "Wren" and "A. N. E. C." monoplanes, which tied with the excellent figure of 87.5 miles per gallon. The former is a cantilever monoplane with the landing wheels partly enclosed in the body, the power plant being a diminutive motorcycle engine of three horsepower, driving an airscrew three feet six inches in diameter, direct. It possesses a top speed of about 55 miles per hour, and was flown during the competition in very rough weather. It was computed that on a fairly calm day this plane would fly for 110 miles on one gallon of fuel. The "A. N. E. C." monoplane with a six-horsepower engine gave a really astonishing performance. Apart from its low fuel consumption, its top speed was in the neighborhood of 80 miles per hour and its best climb during the week was 14,400 feet in a little over the hour. Its ceiling; *i. e.*, the maximum altitude possible, was considered to be about 20,000 feet. This with an engine of 750 c.c. capacity. The high efficiency shown must in this case be attributed to the wing section used, this being computed to possess a lift-to-drag ratio of 22 to 1. This in other words means that the resistance of the wing in flight is only one-twenty-second of the weight lifted. Unfortunately, the addition of a body reduces the lift-to-drag ratio of the complete machine, to an extent dependent on the degree of streamline effect obtained. Thus it is quite possible that although the wing alone may possess a high L/D ratio, that of the complete machine, due to a badly shaped body may be quite indifferent. In the case of the "A. N. E. C." monoplane, the L/D of the complete machine is stated to be 16 to 1. Therefore, as its weight loaded with pilot is 465 pounds, the thrust necessary to maintain horizontal flight at the speed at which this L/D occurs, is 1/16th of 465 = 29 pounds. It will thus be seen that as the resistance of a machine is reduced the reserve power available is increased. This reduction of resistance may be obtained by very careful detail design in which there is a minimum of exposed wires, fittings, etc., or by the production of improved wing forms. The latter point indicates a direction in which these light planes will be of immense value, in enabling experimental wings and the effect of various controlling arrangements to be tried out in flight at low cost, affording an invaluable check on wind tunnel model experiments.



A. N. E. C. monoplane with six-horsepower engine, which flew 87.5 miles on a gallon of fuel, won the altitude prize with 14,400 feet, and came second in the speed contest with a mark of 74 miles per hour

The Wren monoplane which shared the laurels with the A. N. E. C.

The Parnall "Pixie," which won the speed contest, had a top speed of about 90 miles per hour, two laps having been flown at a speed of 82 miles per hour. Only one machine, the Gnosspelius "Gull," departed from the tractor airscrew arrangement. In this machine the engine was mounted on the wing immediately aft of the pilot, driving the twin propellers by means of chains.

The De Haviland six-horsepower monoplane driven by Capt. Broad

The controllability of the machines generally, was excellent, this being instanced by the fact that two were looped during the meeting. In this connection it was obvious that valuable lessons had been learned from the results of the gliding competition at Itford last year.

It is also apparent that with careful design, particularly in the reduction of resistance, it will be possible to construct a two-seater machine with an engine of six horsepower, which will possess a top speed of about 70 miles per hour, a landing speed of 25 miles per hour and which can be housed in a space no greater than that afforded by the average private garage. These machines possess the very valuable attribute of a low landing speed, which at once reduces one of the chief risks of flying, and further permits landings to be made in small spaces. It must be admitted, however, that considerable progress in stability and control must still be made before these machines can come into anything like general use. This, of course, is a matter of time. For the immediate present these machines have a very great value for the preliminary training of pilots and for economical full-scale experimental work. To a lesser extent they will also be available as private touring machines and for sporting purposes.

The Avro biplane, with 3½-horsepower engine, which reached a height of 13,850 feet

Lichens—Impossible Plants

AMONG the most singular and inexplicable of organisms are those known to botanists as lichens. A lichen is not an organism or species in the same sense that we use the word in referring to other plants or animals. A coconut crab or the tree on whose fruit it feeds, an apple tree or an ant crawling on its trunk, each is a distinct species, a definite entity of more or less homogeneous structure with organs and tissues of a common primary origin and a definite common specific heredity. Each of the examples cited is the product of the union of a sperm and an egg cell from like parents and can come into being in no other way.

It is true that some animals and many plants propagate wholly or in some part parthenogenetically; that is, without the fertilization of the egg, and that others increase in numbers through some form of somatic or cell division. But no matter what the exact method, it is impossible to have a coconut crab whose parents were anything but coconut crabs, or to get a cross between a fern and a flowering plant, a liverwort and a moss, a shark and a sardine, a bat and a bird, or even between two distinct mammals like a cat and a dog.

Yet when we examine lichens we find an entirely different state of affairs. A lichen is composed of two entirely unlike organisms, belonging to two entirely distinct and altogether different groups of plants. Biologically a lichen is therefore composed of and is the resultant of the interaction of two distinct and utterly unlike living organisms which go to make up its body. If we section a lichen and examine its anatomy we find it to be made up of a fungus and an alga. The form and texture of most lichens is due to the fungus, filaments often being compacted at the surface to form a thick strong cortex, while from the lower surface they extend as rhizoids or otherwise simulate roots.

The alga, on the other hand, is in nearly every case distributed in a layer within the body of the lichen, but much nearer the upper or outer surface, so that in section it forms a streak of bright green enmeshed in the white threads of the fungus. The fungus of a lichen, however, has the new duty of enveloping and protecting the alga so that the latter may increase in number and perform more effectively the task of manufacturing food for the fungus. A result of this is perhaps the reason for the development of the greatly varied and complex bodies of the higher lichens. The fungus supplies the alga with water and mineral salts and may also carry more or less of its carbon supply with it. The alga is protected in such a way that it is able to grow where it would be impossible to do so alone and its continued existence, through cell division, is assured.

It is this strange association of two unlike organisms, a fungus as master living as a parasite or a saprophyte upon an enslaved alga, which gives rise to the anomalous organisms called lichens, plants which differ markedly from either of their components.—*Abstract from the Scientific Monthly for February, 1923, Article by A. W. Herre, Philippine Bureau of Science.*

Lessons of the Japanese Earthquake

Types of Construction which Survived and Recommendations for Reconstruction

A Resumé of Engineering Opinion

STEEL and reinforced concrete were the structural victors of the Japanese disaster. This, in sum, is the opinion of an engineer employed by one of the largest American construction companies to make a study of the industrial buildings which had been erected by this company prior to the great earthquake which made a shambles of Tokyo and Yokohama.

In company with a Japanese architect, this American engineer made a very careful and thorough examination of a number of structures which remained standing, although in a somewhat damaged condition. The most striking discovery was that practically none of the great steel columns used in these buildings was permanently distorted. That these members had been subjected to violent flexions was at once obvious, for the masonry piers which had enclosed them were very badly shattered, proving the lateral movement of the columns themselves. Especially was this phenomenon noticeable in the second and third stories of the buildings, while the first and fourth had suffered relatively less.

These facts indicate very patently that the steel used was both strong enough to withstand the normal dead load plus the live load superimposed by the earthquake movements, and that it had an elastic limit high enough to insure its full return to original position after an amount of lateral swaying which was at least sufficient to swing electric light globes suspended on two-foot cords against the ceilings and fracture them.

That steel, brick and concrete are no positive insurance against destruction by earthquake shock unless properly designed and unless of good quality, is shown by the severe damage that was received by a large, six-story steel-brick-concrete building of Japanese construction which was so badly damaged that it must be demolished. In this case the steel was left by the earthquake with permanent distortions. Another similar example is that of a reinforced concrete building built by the Japanese, which collapsed and killed 130 occupants. The wreck of this structure is thought to have been entirely owing to faulty construction. Even allowing for such workmanship and design, steel and concrete did not come out with a wholly perfect score. It is doubtful if anything short of canvas tents would. Nevertheless its record is so good, and so much better than anything else that there is little doubt that it will be very largely used in the reconstruction which the Japanese are planning and which they are approaching in a truly scientific manner in an attempt to avoid making the same errors again.

Even horizontal reinforced-concrete floor slabs remained intact, or nearly so. At the points where bays or sections of the parts of each building joined there were some minor cracks in the floor construction, but these were points where the several sections of the building vibrated independently of each other, setting up shearing stresses that were too severe for even the strongest materials to withstand. It would appear that some damage was received by interior walls made of gravel-reinforced concrete, but these are not serious enough to preclude repair of the buildings.

Masonry piers suffered quite badly, especially on the middle floors of low four-story buildings.

Practically all kinds of facing material failed. Tiles were the most resistant of materials of this class to damage and dislodgement. Next in the order of resistance comes stucco; followed by granite, cut stone and terra cotta. Interior partitions made of hollow tiles were utterly unable to withstand the crushing stresses caused by the lateral movement of the columns, and they fell in fragments. But partitions made of plaster on metal lath were not nearly so severely damaged. Still better behavior was given by partitions of concrete, while those of reinforced concrete fared best of all. Even in this material, however, there were some cases of shattering resulting from horizontal shearing, and this was most evident in the case of partitions made of slag concrete.

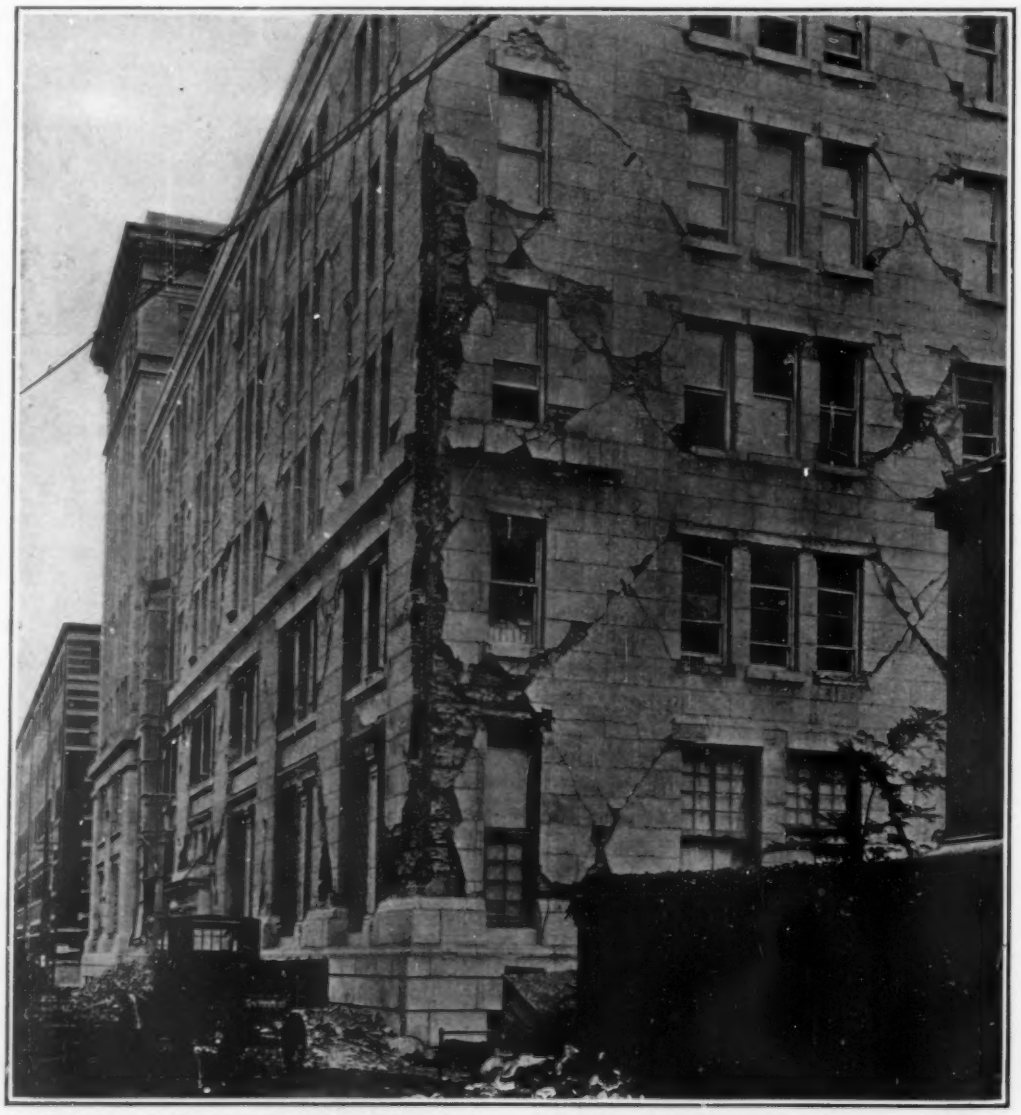
Thus it is evident, judging from the experience of one large engineering construction firm, that steel and reinforced concrete are the materials best suited for construction in earthquake zones, provided that steel of proper strength and high enough elastic limit to return to its original position, is specified and used, and provided that concrete made of carefully chosen materials, properly mixed and carefully reinforced, is employed.

As a result of these observations a number of interesting recommendations were submitted by the engineer on the ground. If Tokyo and Yokohama are rebuilt—and, of course, they will be rebuilt, for the Japanese certainly are not the sort of a people that will waste time in lamentation before setting to work to put their shambles in order—it is believed that all foundations should be of piles capped with reinforced concrete; or of isolated pier spread footings; or of solid concrete mats without piles. These piles are in no case to be driven to hard pan or to "refusal." In this manner full advantage is to be taken of the natural cushioning resilience of the earth. For if the piles were driven to rock the full severity of the earthquake shocks would, in the event of another earthquake (an event that is practically inevitable), be transmitted directly up through the piles to the building. For this reason it is advisable that deep basements should be avoided.

Steel columns should be placed in a straight line in either direction so that at every panel there will be a maximum number of points of resistance. Moreover the sections of these columns should be as wide as possible in each direction and should be connected at each floor by as deep girders as headroom will permit. In this manner it is possible to avoid the use of knee braces. Rivets which are "in tension" should be carefully avoided, and instead, whenever possible they should be used in such a position that they are "in shear."

If concrete is to maintain the splendid reputation for use in earthquake zones that has been awarded it by the gruelling tests of the Japanese catastrophe it is recommended that it be used only after careful screen analysis of the aggregates available, and the water content should be kept down to such a low minimum that the concrete can only just be worked into the forms. It is believed that exterior piers around steel columns should be made of reinforced concrete, while interior columns and connecting girders should be entirely covered with concrete reinforced very thoroughly, both around the columns and longitudinally. Solid reinforced-concrete walls should be used in the interior between columns as well as around elevator shafts, pipe shafts, and stair wells. Lastly, wherever possible, reinforced concrete walls should be built from basement to roof, with a minimum number of openings.

It is an interesting and perhaps significant fact that the two most modern materials used for large industrial and public buildings, namely, steel and reinforced concrete, should also prove to be the best adapted to survival in a region where it is necessary to float the foundation on resilient shock absorbers in order to avoid periodically complete destruction at Nature's unpredictable whim.



A steel building in Tokyo which survived the recent earthquake without permanent damage. Although the right and left swaying motion set up stresses that sheared the outside walls in two corresponding systems of parallel fractures, the steel framework was strong and elastic enough to return to its original form after the last tremor. Demolition will be unnecessary in this case. Steel and reinforced concrete withstood the earthquake shocks best

The Continuous-Traffic Lift Bridge

IN order that bridge traffic may not be interrupted by the necessity of keeping a clearance great enough beneath it to permit the passage of water-craft, a new and unique type of bridge has been designed by Mr. A. A. Henderson, an engineer of Pittsburgh. This bridge does away with the alternative necessity of building a span at so great a height above the street-level that a costly and steep approach must be made. The bridge may be raised in the center with hydraulic jacks, permitting full clearance below for navigation during flood time and at the same time interposing only a low and temporary grade for the approach of bridge traffic. This bridge is not, at least not in the usual sense of the word, a lift-bridge. Rather is it designed to be raised only in time of high water, and then to be kept raised until the water subsides.

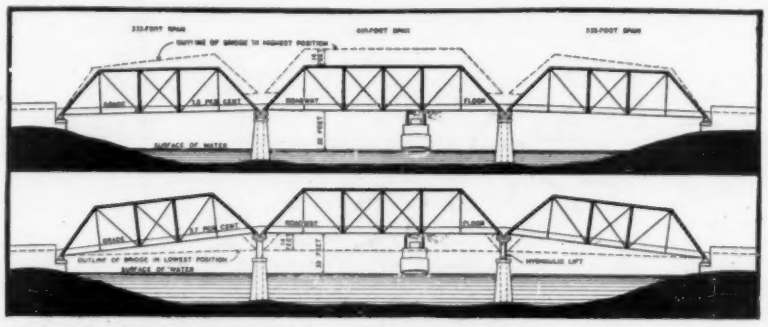
With the center span and the adjacent ends of the shore spans raised there will be, of course, a gap at the shore ends of the latter. Ordinarily this gap will be surprisingly small, introducing no new feature not regularly met with at the expansion joint of all large bridges. In the case of a specific bridge of this type which was designed for the Allegheny River at Pittsburgh, having a center span of 410 feet and two shore spans of 333 feet each, with a total lift of 14 feet this gap would be only three inches, and could be readily provided for. The gradient caused by the tilting of the two shore spans, with the jacks run up all the way, would in this case be 5.7 per cent. But a study of waterlevels at that point shows that there would be very few days in the year when the waterlevel in the river would be so high that the jacks would have to be fully run out.

During 185 days of the year, corresponding to the period of low run-off the bridge would not have to be raised at all, while a full extension of the jacks would be required during only 3.9 days of the entire year.

The jacks necessary to lift the total load, static and live, of 5600 tons would consist of plungers of 32-inch diameter working under a three or four-thousand pound per inch pressure delivered by an automatically controlled pump. In order that the load may not continue to rest on the water in the cylinders after the bridge is raised, four 20-inch follow-up screws are placed near the jacks so that the static load can be transferred to them.

Similar hydraulic jacks are being used in the canal-boat lift at Les Fontenelles, France, on the Nuef-fossé Canal, where a ram supports a weight of 800 tons on a diameter of six feet six inches with a a run-out of 48 feet.

In order to provide for the transverse and longitudinal forces of wind, etc., it will be necessary to have short, steel guide-towers at the ends of the two piers, so designed and constructed as to form a component part of them.



Hydraulic lift-bridge proposed for rivers with a full spring stage of water, to permit passage of boats without interrupting traffic or requiring a bridge of excessive clearance

Bad Coal Ruins Family Wash

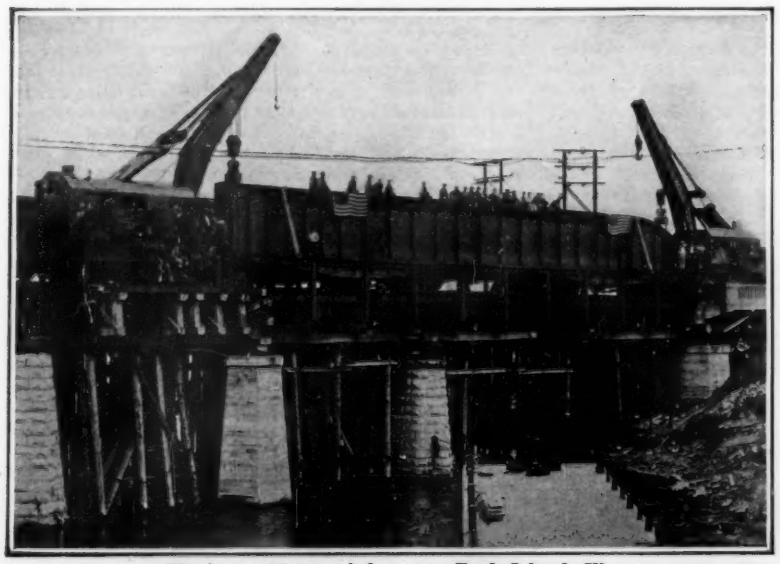
SOME housewives, mainly those living in large cities, recently had the unpleasant experience of having laundry ruined that had been hung out to dry. Silk shirts or dainty underthings have shown brownish stains, and frequently, on ironing the garments, the cloth has broken through at the discolored places, of course rendering the garments useless.

The cause of this distressing phenomena is now revealed. The discovery was brought about through complaints made to the wet-wash laundries by customers, who had had the experience just mentioned with clothes that they had sent away to be washed.

Chemical examination of the brownish spots disclosed the presence of sulfuric acid. While the chemists who made the tests are not prepared to formulate the exact chemical reaction that takes place, they believe that the acid is produced from the conversion of sulfur dioxide (SO_2) in the atmosphere, into sulfuric acid (S_2SO_4) in the presence of the moisture in the wet garment. The sulfur dioxide is easily accounted for as a by-product from the consumption of poor grades of coal, the gas being conveyed by smoke coming from the chimneys. As further proof of the correctness of this explanation, it is worth noting that the trouble has been found to occur mainly on cloudy days, when there is a tendency for smoke to descend. Again, when garments come from the laundry already dried, ready to be ironed by the housewife, the stains are absent; for the laundries dry indoors.

Ninety-Eight Tons of Steel in One Piece

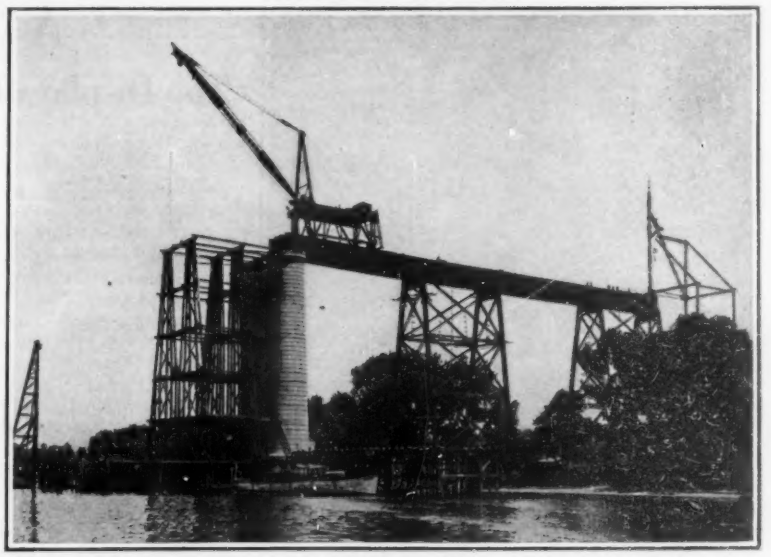
THE heaviest, as well as the longest, steel bridge girder ever used in bridge construction in America, was recently swung into place over the Mississippi river at Rock Island, Illinois. This steel monster is 114 feet long and weighs 98 tons. Its removal from the foundry where it was fabricated required the use of four flat cars and it is said to be the maximum weight that any foundry could produce in one piece.



Placing a 98-ton girder near Rock Island, Ill.

The girder spans a slough of the Mississippi river and forms the last link in a new bridge designed to carry traffic at this point for the next 50 years. At this point, traffic is heavy and the movement between trains is short. The ordinary expedient of diverting traffic to a temporary track could not be made use of. The old superstructure was removed and the new one erected without interfering with regular railroad traffic to any considerable degree. One track was taken out of service during the day but was in service again when the working day was over.

The completion of this bridge, which is expected to progress rapidly, will make possible greater electric power, as the new type of bridge will give full power to the stream current.



New rail bridge across the Hudson below Albany, now under construction

Cutting a Traffic Tangle With a $20,000,000 Bridge

THE awful bottle-neck on the New York Central Railroad at Albany, where every pound of freight and every passenger between the West and New York or Boston have to pass over a very limited number of tracks, will be measurably relieved by the new bridge at Castleton, ten miles south of Albany, now under construction. The bridge will afford a connection between the West Shore and the New York Central lines, without passing through the Albany station of the latter road. Although actual work began only a year ago last June, good progress has been made, as our picture shows. The completed bridge will be higher than the Poughkeepsie span and longer than the Brooklyn Bridge.

Dog Distemper

DISTEMPER is an acute highly contagious disease, presenting symptoms somewhat analogous to measles in man. While some have regarded it as specific for the dog, others consider that it occurs in cats, young foxes, wolves, jackals, hyenas, and even monkeys. From its contagiosity it is certain that the cause is a microbe of some kind, which, however, has hitherto not been unmasked. Indeed, there is very little real scientific knowledge extant on the disease. This is in part, at any rate, due to the fact that what veterinary surgeons and the laity call distemper is almost certainly not one but several diseases. That one of these is the specific disease is, however, very probable.

At present the concept of "distemper" is entirely clinical. Thus, one finds descriptions in the literature of catarrhal, gastric, nervous, and exanthematic types of the disease. There is a great body of evidence to show that one attack of the malady confers a durable immunity on the survivor. The disease occurs in all countries and was apparently known in antiquity. On the other hand, there is a tradition—it is little more—that distemper was introduced into Europe from South America in the seventeenth century. There have been many researches on the probable cause, and from the time of Semmer (1875) down to the present, every known type of microbe has been incriminated.

Many have believed that Carré came nearest the truth with the idea that the *causa morbi* is an invisible microbe which can traverse bacterial filters. With filtrates obtained from nasal secretions he obtained lethal effects which were claimed to be identical with true distemper, and he regarded the visible bacteria found by others as secondary invaders.

This view is largely accepted without criticism. It may be pointed out, however, that Carré's work, which is not given in any great detail, has been adversely criticised by Galli-Valerio, and especially by Kreganow. Filter-passers have been suggested or proved for a number of pathological conditions. They are highly infectious, invisible, filterable, and non-cultivable. They probably constitute a new group of living things, which, if discovered in the case of distemper, may throw a light on many unknown causes of disease in man.

A bed of seedlings at the Arboretum

A Museum in the Open Air

The Display of Trees and Woody Plants at the Arnold Arboretum

By A. A. Hopkins

THE idea of a botanical garden is rather old. We had "physic gardens" in England and "Friend Bartram's Garden" in Philadelphia before the beginning of the nineteenth century and in that century were developed magnificent botanical gardens at Kew, in New York, in Java, in Ceylon, and in many of the capitols of Europe. But it remained for the Arnold Arboretum at Jamaica Plain, Mass., to do away with the glass greenhouses, the invention of Sir Joseph Paxton, gardener of Chatsworth, the superb estate of the Duke of Devonshire. The botanical gardens referred to, of course, have trees as a part of their educational and scientific exhibits, but it is only a part of the whole. It remained for the Arnold Arboretum to develop a unique collection of 5000 varieties of trees and shrubs and the number of specimens which one can see has never been determined. This unrivalled collection is the creation of one man, Dr. Charles S. Sargent, who has the unique distinction of being the only director of an institution which has flourished under one management for over 50 years, for he became the director in 1873 and still presides over this institution. We were fortunate to have the opportunity of spending a most pleasant day with Dr. Sargent who gave some very interesting information relative to trees, which will be referred to later. It was inspiring to see great trees which he had planted and watched the growth of for decades. The handsomest example was perhaps a sugar maple which Dr. Sargent planted in 1885—39 years ago. This is certainly a very beautiful tree, but Dr. Sargent showed the writer larger trees which he planted in the first years of his directorate. This matter is very important as it shows the great crime which has been committed in the United States for 30 or 40 years of cutting down timber and never starting any reforestation. The newspapers and magazines are the greatest active enemies of trees for the capacious maws of the pulp grinders seem to have no limit. We went to Canada the other day to see the largest paper mill in the world and the following is the statistics of wood consumption for one day, 400 cords weighing 960,000 pounds. Fortunately the corporation owning a great chain of mills has seen the light and they are planting. If Dr. Sargent had been heeded and the concrete example of the Arnold Arboretum had been taken at its face value, the economic resources of this country would have been conserved and a long train of evils which result from the displacing of nature's balances would have been avoided. Anybody can plant a tree and they require practically no attention —time is the only element. For trees to grow within the space of one man's life make it a certainty that if proper planting is carried on that a forest tract may last for hundreds of years and supply all the wood necessary for building or industrial purposes.

Now to return to the Arboretum. The history of it is quickly told. A citizen of New Bedford, Mass., left $100,000 for the "promotion of agricultural or horticultural improvements," a splendid bequest. Harvard University became interested and devoted a large tract of land to the new enterprise, 125 acres in all and 90 acres were added subsequently. Dr. Sargent was made Director in 1873 and the Arboretum will remain as the undying memorial to the efforts of a true scientist who has had the rare opportunity to see his life work crowned with entire success. Besides his work of raising considerably over a million dollars, Dr. Sargent's own gifts of money, books, photographs and herbarium specimens have been princely. He has attracted students of trees from all over the world and a group of Chinese students studying trees is not an infrequent sight. The museum which contains the administrative offices, the library and collection of photographs also can accommodate a herbarium of 1,000,000 sheets in steel cases and one of our engravings shows the bulk of 30,000 specimens obtained as a result of an expedition to Formosa and Korea in 1917-1918.

Arrangements were early completed with the City of Boston by which the Arboretum was fused with the Park System for a period of 1000 years, the longest contract of this nature of which we have ever heard. The city polices the Arboretum, takes care of the roads and walks and releases the institution from all taxes and the people in return are free to wander at will from sunrise to sunset every day in the year. The opening and closing hours are regulated not by man but by the sun. At the time that the arrangement was made with the trustees of the James Arnold estate, the university undertook to grow in the Arboretum every tree and shrub able to support in the open ground the climate of New England. Nobody knew at the time what this involved, as tree developing was in its infancy. It was necessary to find out what trees would grow out in Jamaica Plain and expeditions were sent all over the world to secure specimens to try out. The Arboretum was more than a garden of living plants; it was a great outdoor laboratory to increase the knowledge of trees in every possible way in all parts of the world. Expert advice as to landscape gardening was obtained from that master landscape gardener, Frederick L. Olmstead.

From other botanic gardens the Arboretum differs in its restricted purpose, for it is intended only for the study and cultivation of woody plants. Other public arboreta are parts of general botanic gardens and so sometimes suffer from the want of exclusive attention. In many countries individuals have planted collections of trees, but such collections have lacked scientific control and permanency, and sooner or later such collections disappear without leaving behind them any great addition to knowledge. It has been left to Harvard to establish the first garden which is exclusively an arboretum and which has the size and the promise of permanency necessary for success in its field.

As a museum of living plants the Arboretum occupies in West Roxbury 250 acres of rolling hills, narrow valleys and broad meadow. Natural woods of great beauty and interest cover a part of these acres, and among these woods the collections have been planted in natural groups of genera which are easily reached by grass-covered paths leading from the drives maintained by the City of Boston. There is a special collection of shrubs near one of the entrances in which the species of each genus are planted together for the instruction of visitors who may wish to use a shrub for some special purpose; other collections of shrubs are planted in connection with the trees to which they are related and in less conspicuous positions are arranged for trial and study. The library contains over 30,000 bound volumes and an immense collection of pamphlets.

The Arboretum has stood as a great model and the Federal Government and many of the States have caused the planting of hundreds of thousands of trees based on the advice of the Director after actual experience in propagation of trees in a rather trying climate. Dr. Sargent called the writer's attention to a few facts which are not generally known. One of these is that no trees which grow south of the equator will grow in the Arboretum and that no oak, fir, beech, pine, poplar, hemlock, magnolia, birch or linden grows natively south of the equator. He also said that we have no monopoly in tall trees as our engraving shows. The Juniperus procera of Africa certainly compare with our great junipers in height, and are a great source of the pencil lumber, and the Taiwania cryptomerioides from Formosa grow to a height of 250 feet and are the tallest trees in Europe or Asia. The specimen shown is only 190 feet high and is still growing. Another fact which Dr. Sargent brought out was that trees which grow in the Andes within 50 feet of eternal snow are not hardy in New England.

Taiwania cryptomerioides, of Formosa, reaching a height of 300 feet

The tallest tree of Europe or Asia

Dr. Sargent has been a most powerful influence in scientific forestry in this country and it was a great treat to sit at his feet if only for a few hours.

The best advice we can give is when visiting Boston be sure to spend a few days or at least a day at this great museum in the open air where study is made easy by an elaborate system of labels and guide books and where the material for study is infinite.

Collection of 30,000 herbarium specimens made in Formosa and Korea during 1917-18

Educating Workmen to Accident Prevention

AN interesting scheme for the prevention of accidents by an adequate education of workmen has been devised by the German Syndicate of Civil Engineering Operatives. An energetic campaign was started at the beginning of this year, consisting of the publication, in each issue of the official organ of the Syndicate, of a set of instructive pictures illustrating, on the basis of accidents having actually happened, the main dangers workmen have to guard against. Without resorting to any detailed and tedious description, striking pictures are chosen which at a glance bring home to the most unsophisticated mind, what it is all about, explanatory notes being as concise as possible and reduced to the very minimum. A set of three drawings is given in most cases, the first of which shows the dangerous careless behavior liable to result in accident, while the second illustrates the accident as it actually occurs, and the third, the way of preventing it. In some cases, however, matters are so simple as to call only for two pictures—Figs. 1 and 2 being combined—or even for a single picture illustrating both the danger and its prevention. The series was introduced by two instructive preliminary diagrams illustrating the frequency of accidents with regard to the various parts of the human body and with regard to the various districts of the country respectively.

Inasmuch as professional dangers, especially those of accidents in connection with actual duties, constitute an important factor in the sum of influences impairing the health of a nation and, accordingly, reducing its efficiency, any attempt such as the one above described should be heartily welcomed, the more so as most accidents, with a minimum of care, are avoidable. Similar posters have been used in the United States for many years.

The Pasteurization of Milk

THE general enforcement of pasteurization of milk is called for in the public interest, and there can be little doubt that, step by step, this will come into operation. It is the most practical method of State regulation; and when carried out satisfactorily, it secures immediate safety against serious risks of infection. For many years efforts to improve the sanitary conditions of the farm and the cow-barn have been made, but with results which are quite incommensurate with the expense involved. By dirt tests, bacterial counts, insistence on cooling of the milk at the farm, and allied measures, both the wholesale purchaser of the farmer's milk and the sanitary authority can do much to increase its cleanliness; but pasteurization is the essential safeguard in the public interest. Attacks on pasteurized milk are not scientifically justified, and they involve, if successful, a continuance of the supply of infective milk, with the dangers at present associated with its consumption.—*Abstract from article in Nature for Feb. 3, 1923.*

Motor-Driven "Big Wheels"

ON the pine-clad plateaus of southern Oregon and northern California, where ground conditions are favorable, logging operators for many years have been using a unique method of yarding logs to the railway spurs, known locally as the "big wheel system." Briefly, the method consists of suspending or balancing the load of one or more logs from the axle of a pair of giant wooden or steel wheels eight to ten feet in diameter. The tongue, to which is ordinarily attached two or four horses, is adjustable in length, and extends several feet behind the axle. The "slip tongue" provides the required leverage for raising the logs clear of the ground, and at the same time can be adjusted to keep the load in balance.

The steadily increasing cost of horse feed coupled with the short radius of economical yarding with animals, has led one operator to experiment with motor-propelled "big wheels," a picture of which appears in this connection. It will be noted that the application of the gasoline motor required the addition of two wheels in front to provide the suspension point formerly supplied by the animals and to offer a means of steering the machine.

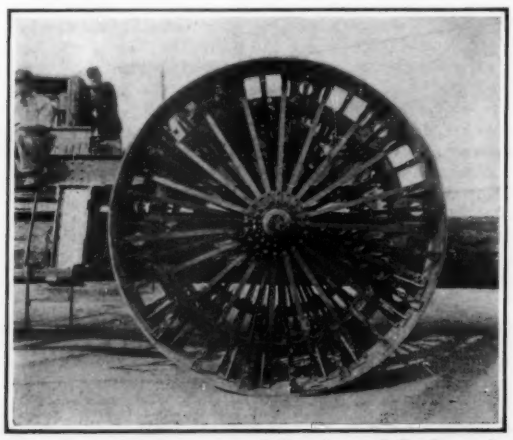
The machine, which has not yet been named, consists of two big wheels 10 feet in diameter with 20-inch tread, together with two power-operated steering wheels six feet in diameter. The frame is built of I-beam structural steel with heavy steel castings. The big wheels are spaced nine feet eight inches from center to center and the inverted "U" axle has a ground clearance of six feet, the same clearance being secured between the steering wheels through the use of an automobile steering device. The machine can straddle a five-foot log and lift it nearly a foot from the ground.

A 90-horsepower motor, mounted on the upper part of the frame, where the gears, transmission and steering devices are also located, furnishes the power for both driving the machine and lifting the log. This power is transmitted to the big wheels through a specially designed transmission and gear and gives the following speeds with the engine turning 800 r.p.m.: low, 1.78 miles per hour; intermediate, 2.69 miles per hour; high, 5 miles per hour.

The power is transmitted to the big wheels by an internal spur gear. A jack-shaft receives the power through the gears from the engine, and in turn transmits it to the big wheels through two gears meshing with two internal bull gears seven feet in diameter, riveted to the rim and to the steel spokes.

The log-lifting device is capable of lifting 20 tons with ease, and is so arranged that the entire power of the engine may be applied to it or released instantly in order that the log may be dropped when the machine is going down hill and serve as a brake. The log hoist is also equipped with brakes, as is the machine itself. The power of the engine is applied to the hoist shaft through gears, and two chains carried on drums on the ends of the shaft are attached to the choker and passed around the log.

The load is then swung clear of the ground, if desired, or the rear ends of the logs are allowed to drag. The hoisting device locks until it is desired to lower or drop the load. The power is then transmitted to the big wheels and the machine moves forward.

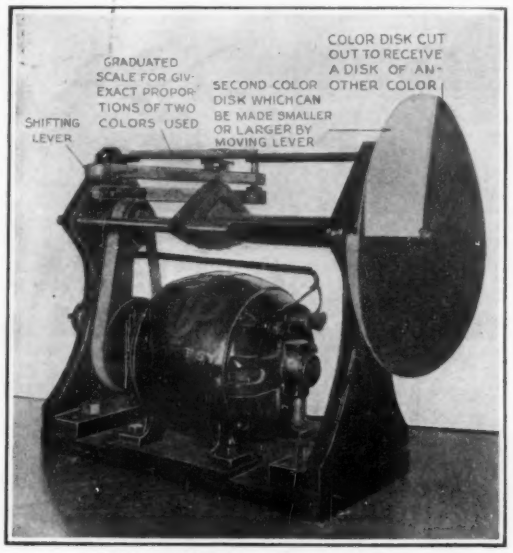


How the motor has usurped the place of the horse in big-wheel logging

A Caterpillar Sprocket Wheel With Removable Teeth

A TRENCH machine has a caterpillar sprocket wheel made with removable teeth, so that when it becomes worn the teeth may be replaced without the necessity of jacking up the machine and removing the caterpillar units in order to remove the worn sprockets from the shafts and replace them with new ones. The center of the new wheel is not subject to wear, and therefore remains in place when once installed. The teeth are easily changeable while all other parts in the caterpillar remain in place.

A second feature of the wheel is the provision of sets of teeth in two sizes—the first a small size for use when the chain is new, and the second a larger set to provide for the elongation of the chain through wear. One of the larger teeth with the extra thickness of the rim section affects the circumferential pitch and takes up the looseness of the worn chain. This greatly increases the useful life of the chain.


GRADUATED SCALE FOR GIVING EXACT PROPORTIONS OF TWO COLORS USED
SHIFTING LEVER
SECOND COLOR DISK WHICH CAN BE MADE SMALLER OR LARGER BY MOVING LEVER
COLOR DISK CUT OUT TO RECEIVE A DISK OF ANOTHER COLOR

The psychologist's color machine

Gliders

AIR Service Information Circular No. 444, published by the Chief of Air Service at Washington, states that the combination of air currents, and topography is the source of energy for gliding, but this energy is available in such varied and complicated combinations that it can not be studied in conjunction with the design of the glider. It should, however, be studied very carefully previous to and during initial attempts at soaring in order to determine whether soaring will be practicable over the regions selected and to determine the location of dangerous zones.

Declivity and thermic currents will be used at first. Attempts to use the internal energy of the wind will be made later, perhaps when satisfactory automatic devices are developed to relieve the pilot of the burden of constant control operation which will be necessary.

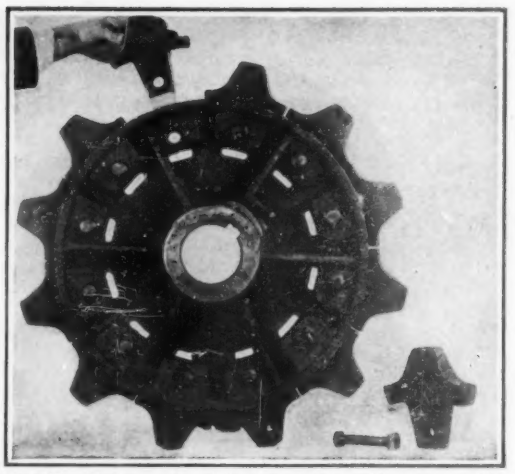
No one type of glider has decided superiority over the others. Biplanes have high aspect ratio and small over-all dimensions, but have high parasite resistance and some interference effect.

Internally braced wings help to reduce head resistance, but high aspect ratio and rigidity are difficult to obtain and profile drag is high on thick wings.

Tail-first types provide better protection for pilots and are otherwise as efficient as tail-aft types.

In all cases the control should be more powerful than on airplanes.

Gliders will have value in training pilots, as observation posts, as targets, and their use in sport for soaring will yield knowledge of meteorology which will result in the more economical use of commercial airplanes.



Details of the caterpillar sprocket with removable teeth

Topographical requirements for a declivity wind suitable for soaring are: A ridge of at least 200 feet in height with a length of one-half mile. The windward side should be straight or concave. Convexity should be avoided, for it will cause diverging air currents. The windward slope should have a grade of not less than 10 degrees and not over 20 degrees. The windward approaches should be clear of trees and brushes for at least one-half mile away, in order to give smooth air flow near the ground and a good landing place.

Trees and brushes will reduce wind velocity and make the landing speed relative to the ground greater. This is the more serious because the glider in passing from a zone of moving air to one of still air will tend to drop very fast and lose lateral and longitudinal control at the time they are most needed.

The back of the ridge should be as horizontal and clear of trees as possible to make landings easier. If the angle between the windward and leeward sides is greater than 15 degrees burble vortices may be present.

Machine for Determining the Psychology of Color

THROUGH the invention of a unique differential, or "two-way" color wheel, by Dr. E. B. Twitmeyer, of the Department of Psychology of the University of Pennsylvania, a problem which has defied the efforts of scientists for many years has been solved. It is generally known that the study of the psychology of color is important in many industrial fields, the textile trades, the advertising fields, etc., and this newly perfected device permits of more delicate determinations of color combinations and color effects than were ever before possible.

One of the remarkable features of this machine is that exceedingly fine adjustments of color relations can easily be made on a whirling disk while the machine is in motion. For example, a yellow disk is placed on the color wheel, and over this is partly placed a blue disk. The two colors blend when the wheel revolves, and the proportions of each color can be shifted by the operator without removing the disks or stopping the machine, this work being done with the aid of an ingenious system of levers and cams. The various disks are cut out in such a shape that makes it an easy matter to move one within another. At the top of the machine is a graduated scale which automatically registers the exact proportions of the two colors as adjustments are made.

Not only does this machine make all kinds of color-mixing an exact science, but it also makes psychological tests of color combinations and values possible. For example, in cases of advertising literature in colors, commercial art work, colored posters, etc., the machine can be used to determine the correct proportions of color for each subject, thus preventing errors as to the application of too much bright color in combination with a darker color. Brilliant colors like red, yellow and orange are often too liberally used in commercial advertising, house decorating, and in other arts, and the new color wheel is capable of pre-determining the proper colors and proportions of color in every case.

When in actual use, a gray background is placed behind the whirling disk of the machine, and a box-like arrangement fits over the front, allowing for a variation of lighting effects somewhat like those on the stage of a modern theater. By means of these lights and the disks of all the principal colors, many important facts relating to color are clearly demonstrated.

The Blue Ribbon of the Atlantic

Rapid Growth in Size and Speed of Turbine-Driven Ocean Liners

SO MUCH deplorable and unnecessary confusion was injected last year into the question of the relative size and speed of passenger ships, that we are writing this little story so as to place the exact truth before the readers of the SCIENTIFIC AMERICAN. Our facts have been gathered from the builders and operators, naval architects, engineers, ships' log-books and the records of the companies of each individual ship.

The table of silhouettes below is drawn to a common scale. It should be explained that the best all-day speed has been achieved sometimes to the eastward and sometimes to the westward, and that it was not always made on the day of the longest run.

It is a curious fact, that though the largest of these six ships is also the latest to be built, the fastest of them, the "Mauretania," was the first to be built; and it should also be noted that with the exception of the "Olympic," all the vessels constructed throughout the 17-year period under consideration carry the same type of motive power. The opening of the twentieth century found the German companies in possession of the blue ribbon of the Atlantic, which was held jointly by the "Deutschland" and the "Kaiser Wilhelm II." These ships, with reciprocating engines, of from 35,000 to 40,000 horsepower and a speed of 23½ knots on a consumption of 1¼ pounds of coal per horsepower per hour, reached the high-water mark of reciprocating engine development.

The Cunard Company built the "Lusitania" and "Mauretania" to win back the trans-Atlantic record, and they made the bold venture of equipping these ships with the then comparatively new steam turbine. They were an immediate success and raised the trans-Atlantic speed by 2½ knots, the "Mauretania" making the trip from Queenstown to New York in 4 days, 10 hours and 41 minutes at a speed of 26.06 knots and covering in a single day of that run a distance of 676 miles at a speed of 27.04 knots. Had the "Mauretania," on that trip, started from Cherbourg and followed the usual course, her time would have been 4 days, 23 hours and 2 minutes or less than 5 days. These records have never been surpassed on the Atlantic route, and they were made with coal as fuel. This winter she is being equipped for burning oil fuel, and it is probable that during the next season of 1924 she will show an even finer performance. Her superiority in speed to the "Majestic" and "Leviathan" is due to her remarkably fine lines, and to the fact that with one-third less displacement, she has only a little less horsepower.

When the White Star Line decided to place two new ships, the "Titanic" and "Olympic" in service, they made no effort to match the speed of the "Mauretania," and aimed rather at great size and comfort. The length was raised from the 790 feet of the "Mauretania" to 886 feet, the beam to 92 feet, 5 inches, and the displacement to 53,500 tons. The turbine drive was adopted only in part, the motive power consisting of two turbine engines each driving a wing propeller and a central reciprocating engine. With 55,000 horsepower, this ship has made an eastward passage in 5 days, 12 hours and 38 minutes at an average speed of 22.61 knots. Her biggest day's run is 559 miles, and the best all-day speed stands at 23.10 knots. Originally a coal burner, she was altered to oil burning in 1920.

Three years later, the Hamburg-American Company put in service the first of a trio of great German liners, the "Imperator," which now is sailing under the Cunard flag as the "Berengaria." She was the first ship to exceed a length of 900 feet and her displacement at 39 ft. draft is 63,090 tons. The passenger accommodation was increased by the addition of one deck more than was found in previous large ships. She is driven by the same Parsons type of turbines, driving four propellers, which was introduced on the "Lusitania" and "Mauretania." She cut down the time of the eastward passage to 5 days, 10 hours and 50 minutes, making an average of 23.40 knots throughout the run. The best day's run to her credit is 577 miles to the westward, when she averaged 23.55 knots with a horsepower of 65,000.

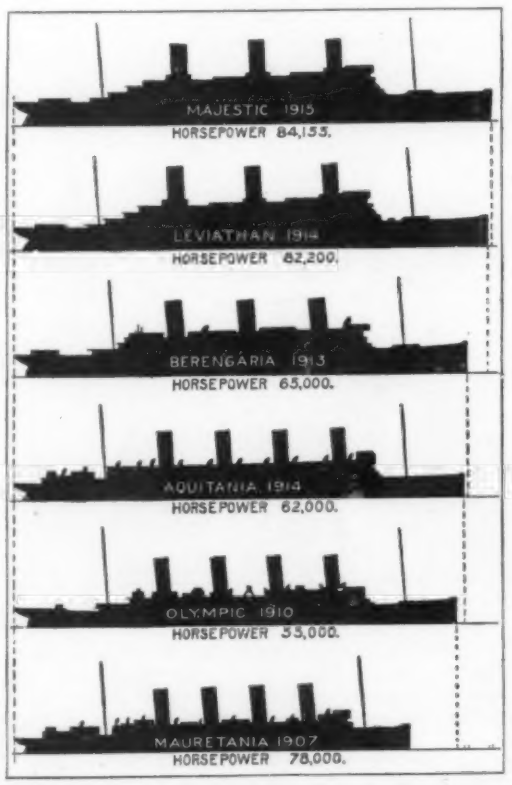
It should be noted that although the length of the "Berengaria" over all was originally 919 feet, it is now 909 feet. This is due to the fact that the Cunard Company removed the enormous bronze eagle with which she was adorned, whose beak projected ten feet beyond the bow of the ship. In the following year (1914), the Cunard Company added to their fleet the "Aquitania," 901 feet on deck by 97 feet beam and a displacement of 53,176 tons on a maximum draft of 36 feet 3 inches. Her fastest trip to date was made to the eastward in 5 days 11 hours and 28 minutes, at an average speed of 23.51 knots. Her fastest day's run was 602 miles, made on her first voyage to the westward, when she averaged for that day a speed of 24.32 knots with 62,000 horsepower. The "Aquitania" is one deck less in height than the "Berengaria," and because of her lower freeboard and upper works, looks her length more than the bigger ship. Like the "Lusitania," the "Aquitania" is equipped with Scotch boilers and quadruple screw Parsons turbines, and in common with all of the big ships she has made the change from coal to oil firing.

In the same year, 1914, the Hamburg-American liner "Vaterland" made her maiden trip to New York. Of the same general type as the "Berengaria," she came from the drafting board of another designer, and is not only a larger vessel, being 41 feet longer and of two feet more beam, but the provision of a cruiser stern and a general refinement of her lines, with certain improvements in the motive power, render her a faster vessel. Like the "Berengaria," she has 46 water-tube boilers, and four screws driven by direct-connected Parsons turbines. After doing great service as a transport for American troops during the war, she was thoroughly overhauled and reconditioned, equipped with oil firing and placed on the Atlantic route under the Shipping Board. Her length is 950 feet, beam 100 feet and on a draft of 39 feet she displaces 64,100 tons. During her service between Cherbourg and Southampton, she has performed very consistently, and on her last trip to the westward she captured the record with a run of 5 days, 7 hours and 20 minutes at an average speed of 24.17 knots. On several days she covered

(Continued on page 144.)

Length on Deck	Breadth	Draft	Displacement in Tons	Fastest Passage	Average Speed for Whole Trip	Best Single Day's Run	Best All-day Speed
956 ft.	100 ft.	39 ft.	64,800	D. H. M. 5 5 21 Eastward	24.76 knots Eastward	609 miles Westward	25.66 knots Eastward
950 ft.	100 ft.	39 ft.	64,100	D. H. M. 5 7 20 Westward	24.17 knots Westward	617 miles Westward	24.92 knots Westward
909 ft.	98 ft.	39 ft.	63,090	D. H. M. 5 10 50 Eastward	23.40 knots Eastward	577 miles Westward	23.55 knots Westward
901 ft.	97 ft.	36 ft. 2 in.	53,176	D. H. M. 5 11 28 Eastward	23.51 knots Eastward	602 miles Westward	24.32 knots Westward
886 ft.	92 ft. 6 in.	35 ft. 6 in.	53,500	D. H. M. 5 12 38 Eastward	22.61 knots Eastward	559 miles Westward	23.10 knots Eastward
790 ft.	88 ft.	36 ft. 2½ in.	41,590	* D. H. M. 4 10 41 Westward	26.06 knots Westward	676 miles Westward	27.04 knots Westward

SILHOUETTES TO SAME SCALE OF SIX FAMOUS LINERS



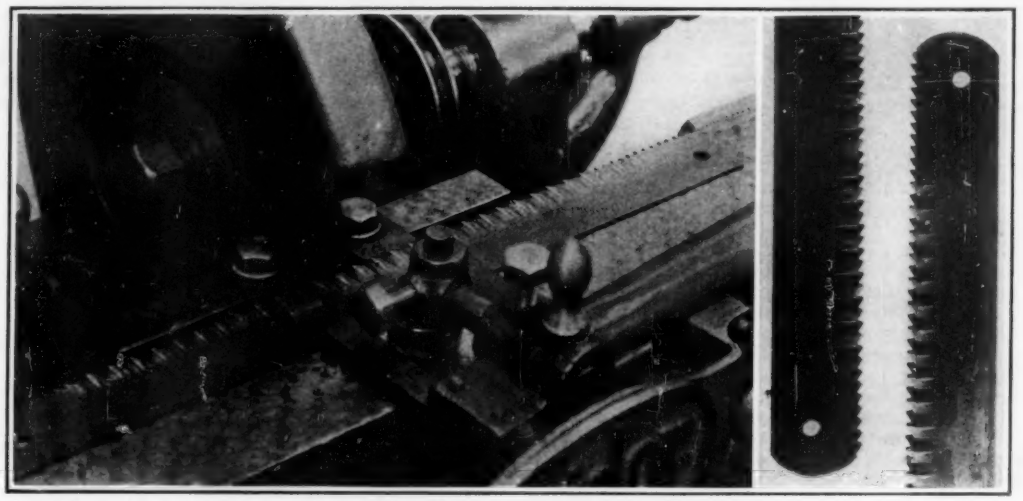
Dimensions of Transatlanic Liners and Their Best Ocean Records

*This record made between Queenstown and New York. Had she sailed over the Cherbourg-New York route at the same speed, her time would have been 4 days, 23 hours, 2 minutes

A Hack-Saw Blade That Improves With Age

A NEW type of hack-saw blade made of 18 per cent high-speed tungsten steel, hardened throughout, is shown in the accompanying illustration. The peculiar form of teeth will at once be evident; and as the patent set extends beyond the root of the teeth, the blade can be sharpened until the original teeth have been entirely ground away and the new teeth formed will still have sufficient set to clear themselves while sawing. It is interesting to note that the blades cut progressively faster after each sharpening.

The new hack-saw blade can be sharpened on any suitable grinding machine, but that illustrated is specially arranged to secure the correct form of tooth for quick cutting. The wheel, trued by a diamond to the correct angle, remains in a stationary position. The blade, moving towards the wheel in contact with the models as shown in the close-up view, has its teeth always ground to the most efficient shape, while the teeth are ground on both faces. While a blade with ordinary set can be ground three or four times at most, the type under review can be ground twenty times, so that its economy in use is obvious. Further, the blade actually improves with regrinding.



Special machine for resharpening the special hack-saw blades which are shown at the right. These blades may be sharpened several times and even improve with age

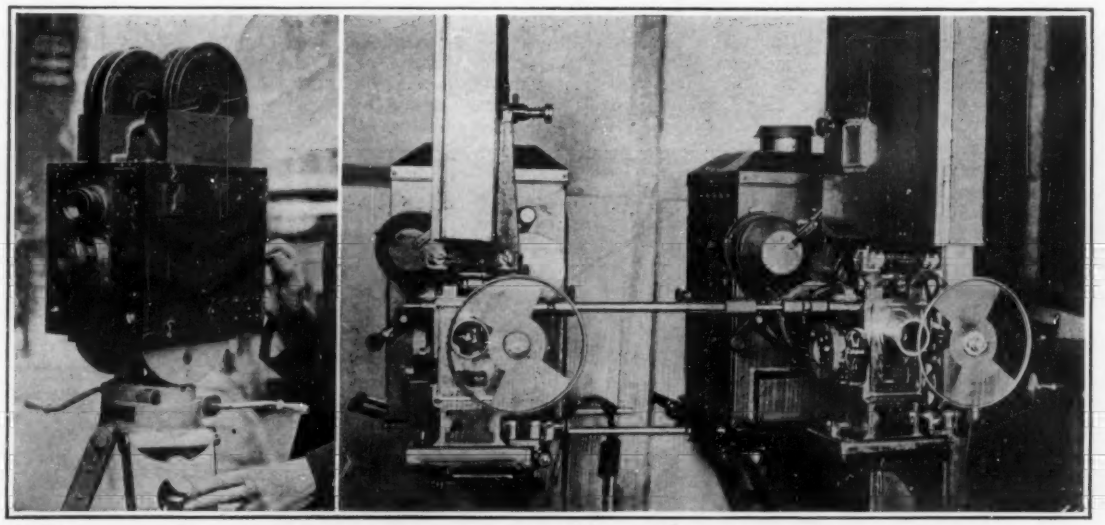
A cutting machine fitted with one of these blades has a capacity up to 10-inch round bars. It runs at 170 r.p.m. and puts a heavy pressure on the blade. The saw holders have an indicator to show correct tension on the blade and a special arrangement to enable a start to be made on a sharp corner without danger of breaking the teeth, and for cutting a groove before full pressure comes on the blade.

The capacity of this machine, fitted with these special blades, is remarkable.

Doubling the Field of Vision of the Movies

THE lens of the ordinary motion-picture camera has an angle of view of thirty degrees. A motion-picture camera recently invented, on the other hand, has two lenses so arranged that they act in the same plane and have a combined angle of view of sixty degrees. This camera does not need to be placed more than 20 feet from the "set" or scene, and every shot is practically a "close-up." Because of the wide angle of view of the combined lenses, athletic events, such as football, baseball and similar scenes can be shown with the entire field in one picture and with close-up value.

The new motion-picture camera carries two rolls of film and takes simultaneously two views in the same field which are united in projection, making a perfectly matched-up picture that takes in twice as much field of vision as any other camera. When it comes to projecting, two projectors are used, connected by a simple attachment so that they work in unison. When these twin projectors are employed a 30-foot screen will replace the usual 15-foot screen. The eye-strain caused by looking at motion pictures will be nearly done away with, as the 60-degree angle of view obtained by this method is almost that of the human eye, which is 65 degrees.



Two lenses recording matched-up images on two rolls of film, and two projectors geared together and matching up their screen images, produce "movies" twice the normal width

It is held by the inventor of this new wide-angle cinematography that the educational value of the motion picture will be greatly enhanced by this invention, as there will be much less breaking up of continuity, more background and more atmosphere in the pictures. Not only will the new pictures be much more real in a dramatic sense, as indicated by these suggestions; but the nearer realization of the angle of vision of the human eye will insure that they will look more like the things we see by direct vision.

Seeking a Non-Destructive Method for Testing Wire Rope

THE various factors which determine the life of a wire rope in hoisting service frequently affect the inner structure of the rope and the result is not evident from visual inspection. For this reason it is difficult to estimate the remaining strength of a rope which has been some time in service. It is the present practice to retire a rope from service when in the judgment of an experienced inspector its remaining strength has fallen below a certain percentage of its original value. The relatively small number of accidents which can be traced to rope failure gives evidence that it is customary to err on the safe side by removing the rope from service long before its capacity for useful work has been realized. This, of course, is a safe practice but leads to an economic loss which could be avoided if a satisfactory method for testing the rope without injury, and without danger of an over-estimate, could be applied.

The Bureau of Standards is now investigating the possibilities in the way of a non-destructive method for testing wire rope in service. Such a method must obviously be based upon correlation between the strength of the rope and some physical property or properties which can be measured on the rope in place and without injury to its structure. External wear and corrosion are easy to detect by visual inspection, but a successful method for test must indicate also the result of internal wear and corrosion which are not visible, as well as fatigue and overstrain which actually change the properties of the material and thus alter its strength.

Magnetic tests would appear to be most convenient of application and consequently are being given first attention; indeed, there have been previous attempts of promise to correlate magnetic permeability with tensile strength. The fundamental relationships between the mechanical properties of the material of which wire rope is made and its magnetic properties will first be studied, in order to determine whether or not a magnetic method could reasonably be expected to work. If such correlations can be established, it should be a simple matter to devise apparatus which can be applied to hoisting ropes in place and which will supplement the present methods of visual inspection or even replace them entirely.

Truck News From Abroad

A MOTOR rail train comprising a five-ton truck chassis and trailer is being used successfully in the Mildura District of Victoria, the dried fruit center of Australia. The main car carries 65 passengers and the trailer 10, the trailer being devoted mainly to freight. This train makes four round trips daily between Mildura and Merbein at an average speed of between 30 and 35 miles an hour, over tracks of the Victorian railways. The steam train which it replaces made only two daily round trips. With gasolene selling at 72 cents per imperial gallon the cost of running this motor train is only about 14 cents per mile.

The use of motor trucks in hauling copper ore in the Belgian Congo has proved successful. The Director-General of the Union Miniere has given this means of transportation a trial with the idea that at a cost of four francs per metric ton-kilometer it would be profitable to change to motor transportation. One American truck has been able to haul copper ore at a cost of 1.08 francs per metric ton-kilometer.

Three motor-bus lines are now being operated between Damascus and Beirut, Syria. One of these is being managed by a railroad company which has a rail line running between these points. There are also two bus lines between Damascus and two other cities. The privately owned cars registered in this area now number about 160 as compared with about a third that number a year ago. The American consul in this territory reports that the demand for motor transport is on the increase.

The most important regulation in the motor vehicle law of Jamaica prohibits the importation or use of any motor vehicle exceeding fifty hundredweight (about two and one-half tons), except upon conditions decided by the governor in privy council. This would indicate that all commercial vehicles except light delivery wagons and three-quarter- to one-ton capacity trucks would be barred from the highways of the island.

Taxicabs will make their first appearance in Hongkong this summer. The Government approval for the inauguration of the service has already been obtained and the projected plans provide for a fleet of thirty cabs, which will eventually be increased to 200, distributed over the important points of the colony. The lack of transportation facilities commensurate to the growth of Hongkong has been the chief factor in the establishment of this motor service. The city is built on a very steep slope, and at present the principal methods of transportation are jinrickshas and sedan chairs drawn or carried by coolies. Owing to the competition from the low-priced jinrickshas, the charges for the new service have been made quite reasonable.

The late President Harding seated beside his photo-sculpture bust, which is one-eighth larger than life size

With Camera and Chisel

Still Another Form of Photo-Sculpture in Which Simplicity and Efficiency Go Hand in Hand

By J. Hammond Smith
Professor of Engineering, University of Pittsburgh

SCULPTURE produced in remote ages was crude because the means for reproducing the forms of nature were also crude. The methods of measuring and the tools for carving were probably invented and made by the sculptor himself. These were very poor and used without much skill, as the workman rarely passed the stage of the amateur, there being little fostering demand as an incentive to continued effort. As the development of sculpture is traced down through the ages, it is found that quality is closely linked with the means for producing and the incentive for continued effort of the sculptor, in the form of livelihood, honor, and appreciation of his work.

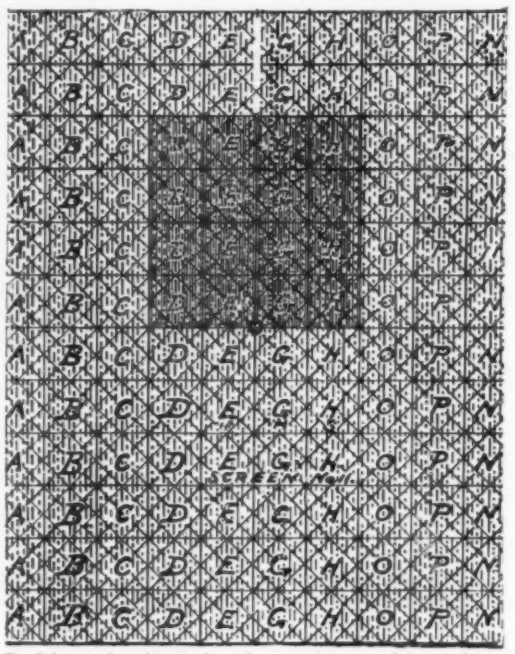
Development of the art down to the present time has produced many "schools" of sculpture, copying after the master sculptors who have specialized in the development of certain features. In many cases, the devoted pursuit of the conventionalisms thus introduced have retarded the development of true art. Those who have taken nature itself as their true guide have made the greatest progress.

Most well informed, wide awake, progressive, and up-to-date sculptors of the present, are unprejudiced against new developments tending to refine and improve their art. Yet there are many who still use the methods of the old sculptors, making many crude measurements and compelling their models or patrons to pose for hours and sometimes days, before the production begins to assume the form of a likeness.

The arts have reached a stage of development where an admixture of science is recognized as a means of producing a most stimulating effect. The chemistry and color effects of artist's paints, art-glassware, art china, stained glass, and the electric illumination of paintings, frescoes, lamps, fountains and art glass, are only a few of the many applications of science to art. In most of these cases, art is indebted to the true men of science; for, truth to tell, very few of the unaided artists would, without the aptitude and special training required, have been able to evolve these improvements.

Thus it is that a scientist of the University of Pittsburgh has worked out photo-sculpture, a most remarkable advance step in the art of sculpture. Several years have been devoted to the development of the original idea, until now the method and apparatus are in smooth working, practical form. There have been other similar systems of photo-sculpture developed abroad and described in past issues of this journal.

The present photo-sculpturing device is simple, consisting of a center rotating stand and two "camera-projectors." The center stand may be rotated about a vertical axis and stopped in any desired position. A chair for the subject is attached to the top of the stand when making the photographic records of form, a modeling stand replacing the chair during the building or carving of the statue. The two camera-projectors are alike excepting in details, and, as the name implies, may be used as cameras or slide projectors. For work of reasonable size, such as portrait busts, they are set pointing toward the center stand, several feet distant, and several feet away from each other, so that their optical axes form an angle of ten to forty-five degrees, having its vertex on the vertical axis of the center stand.



Positive print from the glass screen used in making record photographs

In making photographic records of the subject, one camera-projector is used to project the screen. This screen is simply a system of markings on clear glass, and is projected upon the subject as a lantern slide. The other camera-projector is used as a camera, taking pictures of the subject while under screen illumination, as shown. Any number of these pictures may be taken to get the record of the subject on all sides, but four is ample for a portrait bust. Now these photographic plates, in conjunction with the screen, embody a very accurate and complete record of the form of the subject. These permanent record photographs may be used at any time for the production of the statue, the record of which is virtually contained within them.

In the production of statuary, the record photographs, usually in the form of the original glass negatives, are used one at a time, by projecting them from the same position as they formerly occupied in the camera-projector, when the photographs were made. For each marking (letter, line, etc.) found on the photograph, a corresponding marking will be found on the screen, because all markings on the photograph were produced by the projected light passing through the screen to the subject and there being reflected back into the camera to the photographic plate. Therefore, it may be readily understood that if both photograph and screen are projected simultaneously, the light beams from corresponding markings will cross in space at points where these beams were reflected from the subject to camera, when the photographs were made. Therefore, if material such as clay, be built on the modeling stand, at the point where these corresponding light beams cross in such a way as to cause the image

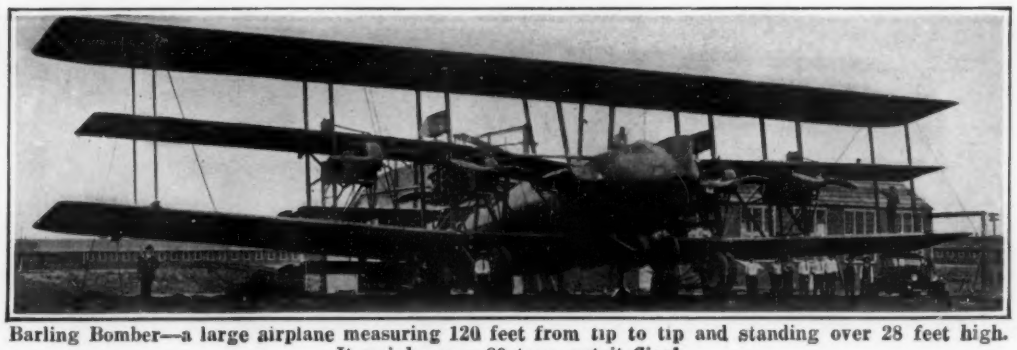
(*Continued on page 144*)

Left: Illuminating photograph which is made into a colored slide for the purpose of projecting a life-like image on to the finished bust. *Center:* One of the record photographs of the late President Harding, showing the screen markings. It is from the record photographs that the bust has been made. *Right:* Clay bust of the late President Harding, just after finishing by the photo-sculpture method

Three phases of photo-sculpture, beginning with the posing for the record photographs and ending with the finished bust

A Giant Among Airplanes

STAGGERING to the imagination is the mere suggestion that a 20-ton—40,000 pounds—airplane is being contemplated! Yet, in the recent completion of the Barling bomber at Wilbur Wright Field, Dayton, Ohio, the largest aircraft in the world is an accomplished fact. The immensity of its proportions suggests the tonnage of locomotives, bridges, buildings, or other earth-clinging objects instead of a machine for navigation through the tenuous air.



Barling Bomber—a large airplane measuring 120 feet from tip to tip and standing over 28 feet high. It weighs over 20 tons, yet it flies!

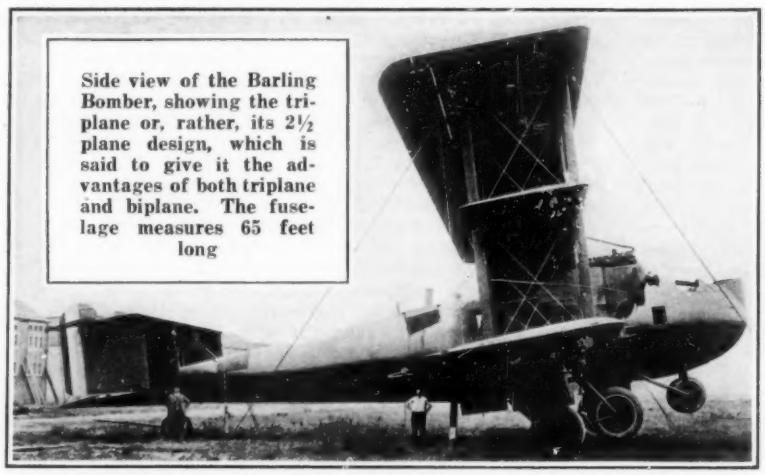
This Goliath of aircraft, designed by Walter H. Barling for the Air Service of the War Department, has accommodations for safely transporting 5,000 pounds of bombs, and could lift and carry, for two hours, a 10,000-pound bomb. Other than its liberal provisions for instruments and ammunition for aerial warfare, this air-going machine affords room for six tons or 2000 gallons of gasoline, 1356 pounds or 181 gallons of oil, and a crew of four or more persons. When loaded, the weight of this airplane exceeds 40,000 pounds, and it travels through the air at a speed of not less than 90 miles an hour.

It is a triplane, or according to technical description, a 2½ planer in that the arrangement of its aerofoils partakes of the advantages of both triplane and biplane. The Barling bomber is 28 feet high, its over-all length is 65 feet, and from tip to tip of its wings measures 120 feet, a pigmy compared to the 74-foot wing-span of the largest bombing aircraft now employed by the Air Service. A half-dozen Liberty motors are necessary to transport this 20-ton flying machine through space.

Spruce, said to be the choicest of all wood for aircraft construction, is the basic material of this modern Titan. The main-wing fittings are fashioned of 60,000-pound steel, which is deemed preferable to nickel-steel of 150,000 pounds, the latter being used in building "NC-4," the trans-atlantic airship of the United States Navy Department. The tail-skid is of all-metal construction, and the rubber-tired landing wheels are 12 inches through. The fuselage, round in shape, is 65 feet long and 10 feet in diameter, inside measurements.

The world's biggest airplane is scheduled to have a 12-hour full-speed flight capacity. Seven guns may be operated from five positions or cockpits, thus affording a sweeping range of the entire field in which the enemy aircraft may approach. Then, too, gun defence may be augmented if daylight fighting instead of bombing after nightfall is contemplated. The six 450-horsepower Liberty motors are controlled through a centralized control stick, a feature of which is the stoppage of the engines on one side without reducing the driving force of the others. The two pilots are seated side by side, and they may frequently change their positions.

The building of aircraft of such enormous size was prompted by a threefold reason, according to the Air Service of the War Department, namely, the development of an air-going bombing machine to meet fully military requirements; making provision for a flying platform for experimental uses; and a realization of a step in the direction of big aircraft of the future. Of the latter factor, the Air Service does not deem it visionary to contemplate that within the next decade an airplane will be developed having a capacity for transporting and dropping a 30,000-pound bomb. The latter, in the event of war, would rip a crater in the earth 50 feet in diameter and demoralize the warring civilian population. The carriage of such a bomb, however, would require the construction of a 200,000-pound airplane, five times the dimensions of the Barling bomber. Such a development, according to the Air Service, is not improbable.



Side view of the Barling Bomber, showing the triplane or, rather, its 2½ plane design, which is said to give it the advantages of both triplane and biplane. The fuselage measures 65 feet long

Sulfur Corrosion

IN discussing alloys resistant to corrosion before the Faraday Society at Sheffield, Mr. J. F. Kayser said that practically all the trade pamphlets claim that the nickel-chromium alloys they describe are quite resistant to the action of sulfur in furnace gases, but as a result of trials with all the alloys at present available, it had been found that such claims cannot be substantiated. Tests made with single gases showed that some alloys would withstand the action of steam, carbon dioxide, carbon monoxide, ammonia, and even pure oxygen for indefinite periods without scaling. Mixtures of those gases were also found to be quite harmless upon the alloys. The introduction of either sulfuretted hydrogen or sulfur dioxide proved, however, to be fatal to even the highest grade nickel-chromium alloy.

A Device That Takes Care of Worn Brake Linings and Shoes

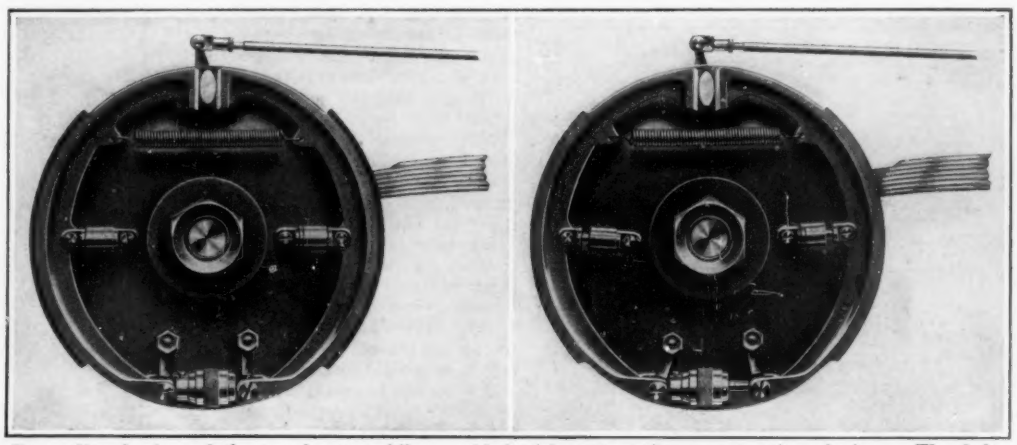
ALL brakes wear out in time. In the case of automobiles and motor trucks, the brakes consist of metallic parts and suitable brake linings, so that some form of asbestos fabric is brought to bear on a metal surface. The friction that takes place causes the asbestos fabric or lining to wear out in time, and eventually the lining must be replaced. In the case of railway cars, the brakes consist of iron members called brake shoes, which press against the hard steel rims of the wheels. In time these relatively soft iron brake shoes wear out and must be replaced by new ones.

Aside from the question of gradual wear, it is necessary to adjust brakes for the best braking efficiency. It stands to reason that as the brake lining or brake shoe wears, the distance between the two braking surfaces becomes greater and greater. Therefore, the brake control must travel farther and farther in order to apply the same amount of pressure as when the brakes were new. After a while it becomes necessary to adjust the brake rigging so as to compensate for the increased space between braking surfaces, or it is necessary to move the braking surfaces nearer to each other.

It has remained for an ingenious French inventor to work out an automatic compensating device for brakes. This device consists of a simple combination of a coarse screw thread, a wedge-shaped member, and a casing, designed in such a way that the device is elongated step by step in the manner of a ratchet mechanism, when given the opportunity. It stretches out as the linings wear down, and compensates for the wear; but it does not and cannot go back.

In the case of the usual automobile or motor truck, this automatic brake compensator may be inserted in the cable or rod controls leading from the lever or pedal to the brakes. The device, when given the opportunity by the wear of the braking surfaces, elongates by one step of its one-way mechanism, so as to keep the control cables or rods always the same length and tautness, irrespective of the worn braking surfaces. Again, the automatic brake compensators may be mounted as shown in the accompanying illustration. Here, in the brake housing, three compensators are employed and serve to spread out the expanding brake surfaces as the latter wear down, so that the cam control, shown at the top, is always moved the same degree to obtain the proper braking effect.

The automatic brake compensator can also be employed on railway rolling stock, for compensating the brake rods for the wearing down of the brake shoes.



Expanding brakes of the usual automobile provided with automatic compensating devices. The left-hand view shows the relative positions with new brake linings, and the right-hand shows positions with worn brake linings

Why Watch Springs Break

HARRY HOLTON, a watch-maker of Wells River, Vermont, kept a record of watch-spring breakages covering a number of years and found that out of 75 breakages during that period, 70 occurred following the winding of the watch at night. Accordingly the following explanation of the cause of breakage was suggested: A watch is carried all day and has acquired approximately the temperature of the body. When removed from the pocket and wound quite tight, the ensuing contraction caused by cooling off of the spring caused it to be strained and lengthened. This effect, it is suggested, is cumulative and the spring finally gives way—usually during the night, after the winding which supplied the straw to break the camel's back.

Since one is more likely to get up at a more uniform hour in the morning than he is to go to bed at night, it is better to wind the watch at that time as it gives a more even power behind the running of the watch. Also, a watch wound at night is half run down in the morning when the owner begins activities that cause various jars to the watch. These little shocks are more likely to check a balance wheel if the full strength is not behind the spring.

This is "Hull Rust," the greatest of all mines. The 300-ton steam shovel, the 50-ton steel railroad car and the 176-ton locomoti

The Story of S

Missabe—The Greatest Iron Mines
Mining in the W

NOW and again something happens in one's lifetime which stands out in the long perspective of the past like some isolated hill in a landscape. Among such memories will ever remain the writer's first sight of the largest of the open-pit mines of the Missabe range, to the north of the city of Duluth. It was in the early hours of a frosty October morning, after a drive through the mining town of Hibbing, that he dismounted near a small wood, passed through it and found himself on the edge of the greatest artificial hole ever dug by man in all the long ages of his history. Between 300 and 400 feet deep was that vast canyon, and from its lowest level it sloped irregularly on either side up to the original surface of the ground, leaving a gap three-quarters of a mile in sheer stretch from edge to edge. For a full two and a quarter miles the awe-inspiring chasm yawned ahead, its further limits barely discernible in the morning haze.

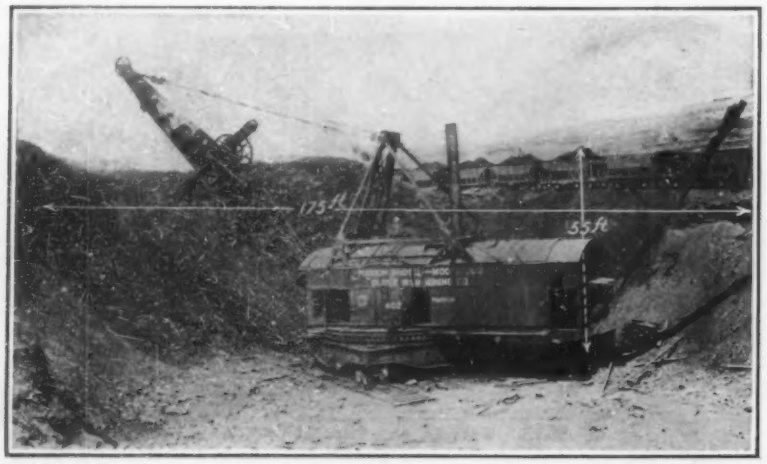
The writer is not devoid of imagination, and he had heard of the Gargantuan proportions of the Hull Rust Mine; he had looked down into the great Culebra Cut at Panama; but for all that he could not repress, if he had wished to, a gasp of astonishment. Here was something which, as a feat of excavation, rendered even the Panama Excavation at its widest point, modest by comparison. Culebra's largest cross-section is found where the big slides have opened out the excavation to a width of 1800 feet on a centerline depth of 240 feet; but at Hull Rust the steam shovel and the ore train had dug and dug and carried away, until we have today a hole 320 feet deep at its lowest point, and extending to a width of 4000 feet at its widest part.

But where are Hibbing and Hull Rust, and why this enormous excavation which, be it known, is only one of over a hundred mines scattered along the great Missabe iron range, which extends east and west for 112 miles? To answer that question, we invite the reader to go by rail and lake steamer to the city of Duluth, which is built upon the steeply sloping bluffs that rise from the northerly shore of the lake. These bluffs reach a rather uniform height of 600 feet; and when the train, climbing on a two-per-cent grade reaches the top of the bluffs, the traveler finds himself on a great plateau which extends, practically level, to the Canadian boundary. Eighty miles inland from Duluth he will reach Hibbing, which is located at about the center of that vast stretch of iron-ore deposits known as the Missabe range. Fifty years ago this plain was given over to forest growth, and the occasional hunter who walked its solitary trails, little imagined that under his feet and not so very far down, was one of the greatest of the treasure houses of wealth which nature had locked up in far-distant ages for the future enrichment of mankind.

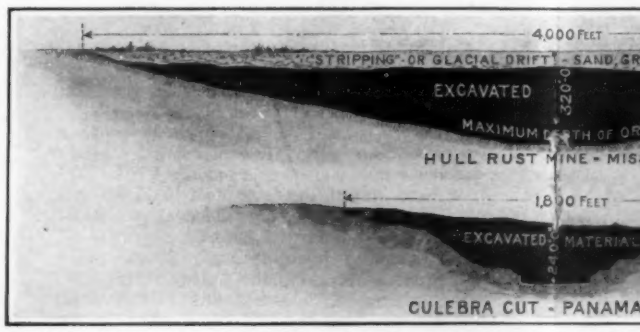
Iron must be placed at the top of the list of metals which have been found in this world; for it exists in greater quantity, and has been put to more widely extended use than any other. You may find it in some measure in practically all of the rocks and earths, and we know how frequently a stream of water, or even the water from a well, will show the characteristic reddish deposit which indicates the presence of iron. The geologist will tell you that millions of years ago great volumes of water, pouring through underground channels, washed out of the various rocks and soils of the earth this rich deposit, and by chemical action changed it into the characteristic red and yellow iron ore, which found a settling basin in the many hollow depressions which characterize the Missabe range.

Only a part of the world's iron deposits can be made into steel; for much of it is so mixed with other substances as to make it very expensive to melt down into iron by any method that man has so far been able to devise. Naturally, the ores which are most cheaply reduced to iron are those which have been most sought after and mined, and the greatest deposits in the world of this character are those to be found in the vicinity of Lake Superior. Not only are these the largest, but they are richer in iron and less burdened with those more or less troublesome elements which always are found with iron ore, such as phosphorus, silicon, sulfur, magnesia, aluminum, etc. Iron ore is valued on the basis of the amount of iron it contains, and also upon the amount of these elements that it contains and the cost of getting rid of them in the blast furnace. We present a map of the Lake Superior region showing in black the location of the various iron ranges, and in another drawing are shown typical vertical sections through these various mines. It will be seen at once that there is a wide variety both in the shape and lie of the ore bodies, and that different methods of mining have to be adopted to suit the local conditions.

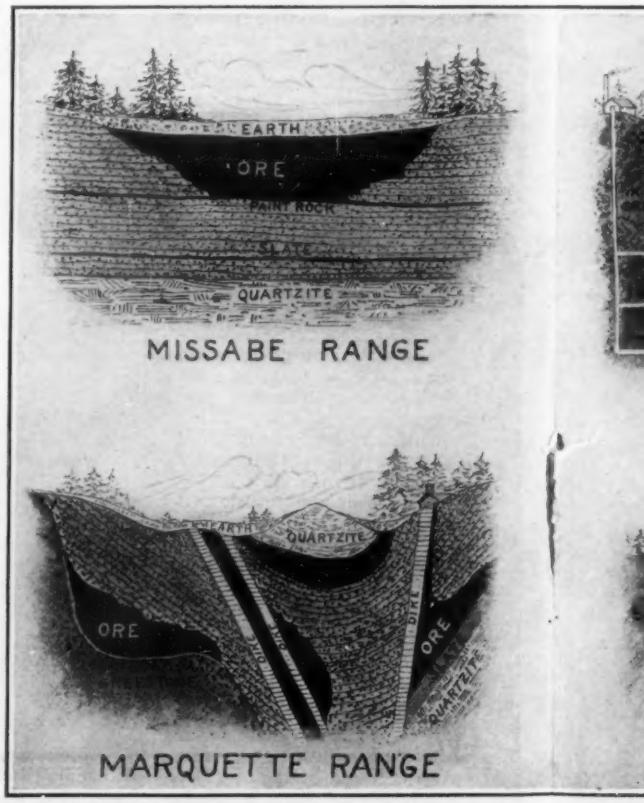
Now, although iron ore has been mined in the Lake Superior region from the middle of the last century onward, it is only of late years that the total output has risen to such great proportions as to give this country its commanding lead in the steel industry of the world; and among all the Lake Superior ranges the one which has contributed most to the growth of our steel industry has been the famous Missabe range, which as we have said, extends in an easterly and westerly direction for no less than 112 miles. Not only are these deposits of enormous size, but nature has so placed them that it is possible to dig them out and remove them at a cost per ton far



This 300-ton shovel makes a cut 40 feet deep and 175 feet wide. The dipper lifts 16 tons at each stroke; the 80-foot boom weighs 50 tons



Hull Rust iron mine and Culebra Cut, Panama, compared at the cavation

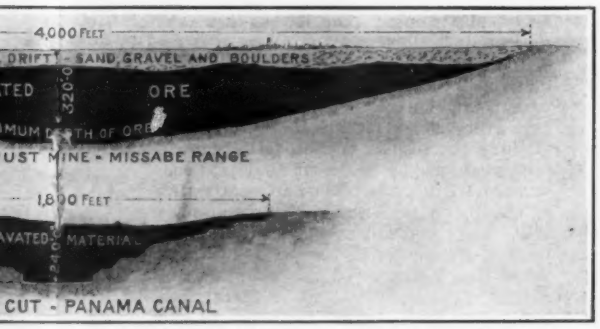


Cross-sections of the principal iron ranges of the Lake Superior d Missabe is mined by "open-pit," the others mainly

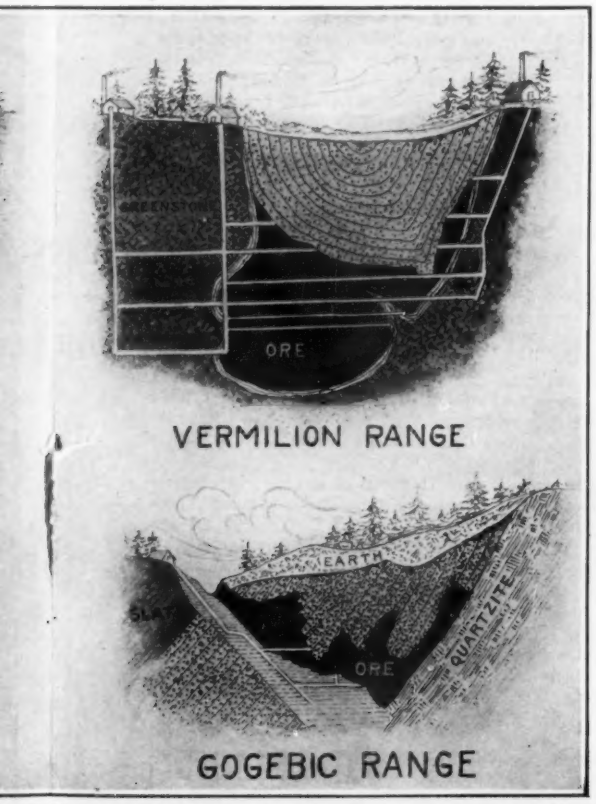
76-ton locomotive have excavated this artificial canyon, 320 feet deep, 4000 feet in maximum width and 2¼ miles in length

y of Steel—II

n Mines and the Most Economical in the World



mpared at the point of their combined deepest and widest excavation



Lake Superior district, showing the position of the ore bodies. e others mainly by shaft and tunnel methods

below that which is possible in any of the mining centers of the world. The ore bodies of the Missabe, as they were deposited ages ago, exist in more or less continuous beds, which vary in width from a few hundred to thousands of feet, and in the Hull Rust and Mahoning Mines, extend without a break for between four and five miles. These ore bodies vary in thickness from a few feet to over 300 feet and from a few acres to several hundred acres in extent. After their formation, the great icecap came crushing and grinding its way down from the north, bringing with it a vast amount of sand, gravel and boulders with which it covered up the ore to an average depth of about 70 feet. There it lay, a vast storehouse of wealth, locked up securely until the day when man should make his appearance upon the earth, and develop to the point where he had the intelligence and the appliances to transmute this raw material of nature into the thousand-and-one steel products demanded by our highly developed civilization.

The first mining of iron ore in Minnesota was done with very primitive tools, such as could be packed from Duluth over a hundred miles of forest to the first mines on the Vermilion range. In the early eighties work was done with pick and shovel, hand drill and wheelbarrow; shafts were sunk and the ore was hoisted in buckets by a horse-operated winch and carted from the mouth of the pit in horse-drawn wagons. Then, with the railroad, came the steam engine, and a few years later the hand drill gave place to the air drill. Later, in the nineties, came the car cage with its landing gates, the stockpile trestle, electric lighting, Corliss hoisting engines and an increase in the capacity of the railroad ore car to 25 tons.

Also in the early nineties, following the methods of the day in deep mining, the miners of the Missabe sank shafts through the overlying glacial drift to the ore body below; but when it was found that the ore lay very close to the surface, the momentous decision was taken to strip off this over-burden and take out the ore by scrapers and horse-drawn wagons. Finally came another momentous advance in the introduction of the steam shovel; and as an inevitable sequence to this came the determination to run the railroad cars themselves down into the open pit and load them directly from the shovel itself.

The system of open-pit mining having thus been started, the problem became merely one of applying the American principle of working with the largest units of machinery that could be built and operated. There was a steady growth in the size from the 35-ton pioneer shovel, until the Oliver Iron Mining Company placed in the Hull Rust Mine the enormous Marion machine shown in one of our engravings. This shovel weighs 300 tons and its dipper lifting 16 tons of ore at one scoop, has 16 times the capacity of the dipper of the first shovel. The early dump cars were of wood and each carried one cubic yard. The present cars are built entirely of steel, and each has a 30-cubic yard capacity. In place of the little six-ton "dinky" steam locomotive, we have the huge modern locomotives with 100 tons of weight on the drivers, which handle the cars in the pit and haul them up the long steep grades to the main tracks above, where they are assembled in trains of 50 to 60 cars for transportation to the ore docks at Duluth.

In opening up a mine on the Missabe range, thorough exploration is first made by means of diamond or churn drills, and the depth of the glacial deposit and of the ore body below is closely determined. If the cost of stripping and mining by open-pit, steam-shovel methods is found to be less than that of deep mining by shafts and tunnels, the open mining method is followed, as at Hull Rust. The operations involved in stripping off and removing the glacial drift are on an enormous scale, for they involve the removal of millions of tons of material to dumps that are located sometimes at considerable distances. Obviously, the material must be deposited on lands which have no available ore below them. The spoil is deposited in dumps of Cyclopian proportions which extend for thousands of yards and reach pretty nigh to a hundred feet in maximum height. These accumulations are as wonderful, in their way, as the huge excavations from which the material is taken. When the ore body has been exposed, the steam shovels cut their way into it, the depth of the cut being governed by the height to which they can raise the ore and drop it into the cars.

In 1920, at the annual meeting of the American Institute of Mining and Metallurgical Engineers at Duluth, it was stated that, since the Missabe range was opened there has been removed 354,301,371 cubic yards of stripping. Compare this with the total excavation of about 240,000,000 yards at Panama. The total stripping and lean ore together would make 363 city blocks, each 300 feet in height. There is a total known ore reserve at Missabe of 1,400,000,000 tons.

The combination of steam shovels of great capacity, large cars, and powerful engines accomplish a great saving in labor, and the output per man per day from an open-pit mine is many times that from the average underground mine. In this respect, the key to the situation is the giant steam shovel, whose huge dipper tears from the side of the cut a mass of ore weighing 16 tons nad drops it into the cars at a height of 50 feet above the rails on which the steam shovel stands. The steel boom which weighs just under 50 tons is 85 feet in length, and the dipper stick some 50 feet in length weighs 18 tons. These figures explain the great horizontal and vertical reach of

(*Continued on page 144*)

Map of the Lake Superior mining district, showing location of iron ranges in black. The rich Missabe range extends for 112 miles

The Heavens in February, 1924

Stellar Distances, and Their Importance in the Astronomer's Work

By Professor Henry Norris Russell, Ph.D.

KNOWLEDGE of the distances of the stars is essential to any successful study of their nature. Without it, we cannot find how bright they really are, or how large or massive they may be; but important as this information on distance is, it is far from easy to obtain. For the nearest stars we can make use of direct methods, quite similar in principle to those used in finding the range for artillery—sighting on the star at times when the earth is on opposite sides of its orbit, and using the convergence of lines drawn to it from opposite ends of this long base line to find its distance. Even so the angle of convergence is so small—but a fraction of a second of arc—that the most refined instrumental means, and one precaution after another, are required to obtain trustworthy results. If a star is within a hundred light-years—which counts as a fairly small distance—two or three observations with great modern telescopes will give us a very good idea of its distance—though the problem is like that of determining the distance of a lighthouse fifty miles away by sighting upon it from two points, two inches apart.

But the large majority of the stars—even of those visible to the unaided eye—are much further off than this, so that we must find some other way to measure their distances, if we are to determine them at all.

Fortunately the astronomer has many strings to his bow. When we cannot get individual results, we can often find a reliable average value. This we do by taking advantage of the sun's motion through space, among the other stars. If only the sun was moving, and all the others stood still, all would be easy. The stars straight ahead of us—close to the point in the sky toward which the earth and sun are moving—would seem to stand still. So would those directly behind us, near the opposite point. All the others would appear to drift backward, from the first point toward the second, at a rate which, for stars at the same distance, would be greatest half way between the "apex" and "antapex," and would diminish gradually toward both. Of stars at different distances, the remoter ones would seem to move more slowly.

Observing with the spectroscope, which reveals the rate at which the stars are approaching or receding from us, we would find all the stars near the apex approaching, those near the antapex receding, and those half way between doing neither one nor the other. The speed at which the sun was moving would then be found, and it would be a simple matter to calculate the distance of any given star from its observed rate of drift.

Actually things are far more complex than this, for the stars are all moving, as well as the sun—some in one direction and some in others, some fast and some slowly. For an individual star, this motion may double or treble the drift due to the sun's motion, or may diminish or even reverse it. But if we take a considerable number of stars in the same part of the sky and average their motions, these individual or "peculiar" motions will trouble us little, for, being as likely to be one way as another, they will "average out" and almost disappear from the mean value; while the drift due to the sun's motion, being always in the same direction, comes out to its full amount when the average is taken.

We can thus get the average drift, and thus the average distance, for all the stars we have considered. (Strictly speaking, this "average" distance is not quite an ordinary average, but it is at least *representative*, representing a star whose motion is the average of the whole.) When our stars are not confined to a small region, but are scattered all over the sky, a similar method, with slightly more complicated algebra, leads to an equally good average value.

If our stars are moving slowly, so that most of their apparent motion arises from the sun's motion, and little from that of the stars themselves, this method gives very good values. But for rapidly moving stars, whose own motions are much faster than the sun's, we can not trust the averaging-out process. The remaining uncompensated effect, though but a small fraction of the motion of an individual star, may be a large fraction of the solar drift; and our results are thus vitiated.

Averages, Probabilities, and Star Motions

But we have still another string to our bow. Consider the part of each star's motion in the sky which is at right angles to the direction of the solar drift. This is unaffected by the latter, and arises only from the motion of the individual stars. Take the average amount of this motion (no longer considering plus and minus signs, but only the numerical values), and we find how fast the stars seem to move, on the average, on account of their own motions. This will evidently depend both upon the average speed, in miles per second, at which the stars are moving, and on their average distance. If we can find the former, we can calculate the latter. But our spectroscopic observations, which can be corrected, one by one, for the solar motion, enable us to find this very thing; and so we get another representative average distance.

We will still need a considerable number of stars to get a good average, for this time we are trusting the numerical values of the rates of motion to "average up" to the same amount, whether we take motions toward and from us, or crosswise. But no *very* large numbers are needed. If we have fifty stars, for example, the results of the averaging-up process should agree in the two cases, half the time, within 10 per cent—which is enough to assure a fairly good conclusion.

By such methods as these we may find the average parallax and the representative distance for any group of stars of which we know the apparent proper motions in the heavens, and the spectroscopic velocities (so long, indeed, as we do not pick our stars in such a way that we give preference to those which are moving in some particular way, and so spoil our averaging-out or averaging-up). It was in this way that the late Professor Ross showed that the representative distance for five-sixths of the stars visible to the naked eye is about 320 light-years; and, in similar fashion, it has been shown that the corresponding distance for the stars of the tenth magnitude (even including the nearer ones, which are faint because they are actually small, and which bring down the average) is fully 1000 light-years.

Other Interesting Cases

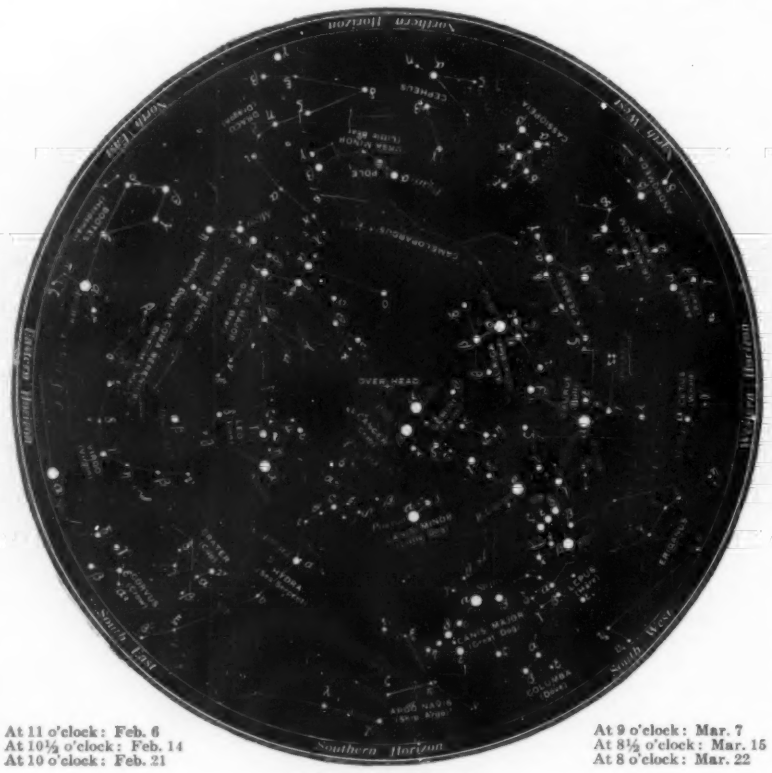
Dr. Wilson, one of Professor Ross' assistants, has recently made in this fashion a very interesting study of the distances and real brightness of the variable stars. Delving patiently into the tabulated records of earlier observations, he has derived the motions of many stars not previously studied, and, with the richer material thus made available, he has obtained excellent average values. Taking first the Cepheid variables—those singular stars which change steadily in brightness, rising to two or three times their original luminosity and falling back again, with exemplary regularity, in periods which range, for different stars, from a few hours to a month—he finds, as Professor Shapley did before him, that the stars of longer period are exceedingly remote, the representative distance for forty stars being 1000 light-years. At this distance, the "representative star" of the group would be of magnitude 6.2—just visible to a keen eye; but the corresponding real brightness comes out 250 times that of the sun. This is the average brightness; as the star varies it ranges from perhaps 150 to 350 times the sun's light. The stars with periods of about half a day (which form a distinct group) look fainter to us, and are also really fainter, though they are farther off. The distance for a typical star of the tenth magnitude, based upon examination of thirteen of them, is 2200 light-years; and the corresponding real brightness averages forty times that of the sun.

These conclusions support those reached some years ago by Professor Shapley, upon which he based his remarkable estimates of the distances of the globular star-clusters. They indicate, from much more extensive material, that the great distances which he then derived are substantially correct. They may, indeed, be slightly too great, but probably by less than 20 per cent—which does not alter at all the conclusions derived from them regarding the scale of the universe.

More recently Dr. Wilson has applied similar methods to the red variable stars, some of which change their brightness irregularly, and by moderate amounts, while others vary by a hundred-fold or even more periodically, with a year or so between maxima. For these stars, as for those discussed above, the results of the two methods of calculation are in good agreement. For a typical variable star, which at its brightest is of magnitude 7.5, the distance, both for those that vary irregularly and for those that are periodic, comes out close to 1000 light-years and the real brightness seventy times that of the sun. The irregular variables fluctuate from this brightness to some 30 or 40 times that of the sun; those of long period often drop to less than the sun's luminosity. At maximum they are normal giant stars in brightness—like hundreds of others of the same spectral types; so that we may regard them as stars which at intervals become faint, rather than as stars normally faint which at times brighten up.

The only exception to this run of average brightness is found among the very old stars, with peculiar spectra, which are known as classes R and N. These are much farther off—at distances something like 2500 or 3000 light-years, and average perhaps 500 times as bright as the sun, though they seem to differ widely among themselves.

It is from just such data as these that we may hope—not quite yet, but perhaps before long—to get the clue to the physical phenomena which cause the variation in brightness.



NIGHT SKY: FEBRUARY AND MARCH

The Heavens

The finest part of the sky is now in the southwest, where Orion, Taurus and the Great and Little Dogs blaze in the clear winter air, with Gemini above them, and

(*Continued on page 144*)

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

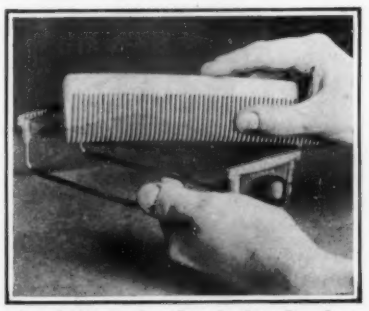
The rapid-fire vegetable chopper

A New Vegetable Cutter

MINT, parsley and similar vegetables need to be cut fine and there really seems to have been no device provided except the kitchen shears which are not an official kitchen utensil, but are used for many of the handy jobs in the kitchen. Now we have a miniature circular harrow which cuts such vegetables as we have enumerated with great speed and precision. The ten disks are very sharp so that the speed of the operation is considerable. The cutting is, of course, much more uniform than when a pair of shears or a cutting knife is used. The use of such devices as this does away with much of the drudgery of the kitchen.

The Universal Comb Cleaner

CLEANING a comb with a pin is tedious, and if one happens to be a hairdresser it is especially tedious. Why not, then, string a number of threads on rows of nails so that the comb can be run along them and all the spaces cleaned at a single motion? Fine and simple. But here's the rub: getting the proper spacing of the threads to fit the spacing of the comb-teeth is rather difficult, and when you come to think that no two combs commonly have the same number of teeth per inch, then the whole thing is not worth the bother. Into the breach steps a Chicago manufacturer with a simple little device that has the stretched threads all nicely and evenly spaced. On opposite ends of two bows of steel wire are mounted two aluminum castings having rows of little posts across their top. On these posts, back and forth, the threads are strung. All ready to clean your comb—No, the spacings are wrong here, too. Easy: the end castings are pivoted on the bows; move one bow away from you, the other toward you. When the threads are the right distance apart to fit the comb, stop. They are always parallel. There is a proposition in geometry about that, but we are out of school—therefore we have forgotten it. Anyway, the comb cleaner works, and works in a jiffy.



A substitute for the pin for cleaning combs

A 10,000-Pound Crane Scale

PRACTICALLY every day industrial progress develops a new use for a weighing device or scale particularly adapted to meet specific requirements. A new scale was developed for the U. S. Government for the purpose of measuring the pull on cables used to hold an airship at its moorings and this scale was immediately adapted for the measuring of unusual, heavy loads on cranes or booms where weights or loads up to 10,000 pounds are handled, assuring that the safe working load is not exceeded, and thus eliminating dangerous overloading and disastrous accidents.

The scale is of steel construction. Its accurate action depends upon four extremely heavy springs. The dial is 15 inches in diameter.

Another Automatic Wrench

ANOTHER "revolutionary" idea in wrenches, if we are to credit the modest claims of the inventor, is that illustrated herewith. As the picture indicates, the tool is another version of the wrench that takes hold instantly and automatically, without any preliminary adjustment. Like the Stillson wrench, it will only work in one direction, this direction being that in which the handle, in the position pictured, is rotated upward. This brings into play the double linkage and the spring, tightening the jaws on the work. If rotated the other way, the wrench, like any Stillson, will open and slide off the work; but when used correctly, it possesses a bull-dog grip, effective at any angle, and with no tendency to slip, no matter how hard one pulls.

The January entry in the automatic-wrench sweepstakes

Paper Saws to Cut Veneer Wood

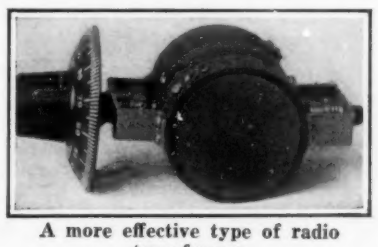
CIRCULAR saws are made of paper, for use in making veneer and fine furniture, and are turned out in a factory in England. Thin plates of wood cut by these saws are so finely finished that cabinet-makers do not have to plane them at all before they are used. Such saws were originally shown at an English exposition and were driven by an electric motor. They are manufactured from a special type of compressed drawing paper.

Indeed, compacted paper of such hardness has been made in England that it has even been utilized in place of building stone. Experiments in the manufacture of car wheels from compressed paper have been made in the United States for a number of years, but the product has never competed seriously with the ordinary steel wheels. It is only in the production of certain articles as the veneer saws that any advantage is found.

The "Transinductor"

WE illustrate a new transforming apparatus, designed by Ernest W. Kersten of Menominee, Mich., which has been very successfully applied in tuned radio- as well as tuned audio-frequency amplification. This principle has also been adapted to transmitting sets in the oscillatory circuit. There are two types of radio-frequency amplifying transformers: The air-core type, and that with the iron core. Anyone wishing to receive a particular wave length could receive with satisfaction with the air-core type, but he was limited as to wave lengths or frequencies to which he could tune in. That difficulty could be overcome by using an iron core, but in so doing amplification was sacrificed. In either case one met with frequent disappointment.

It follows that the ideal transformer should combine air-core amplification



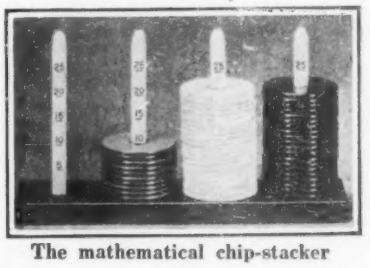
A more effective type of radio transformer

with iron-core tuning range. That has been accomplished in the "transinductor." In this new instrument the action is similar to that of two transformers, the primary and secondary of each being connected in series. The primaries and secondaries being split between rotor and stator, and iron being introduced into the rotor, we obtain through a range of 360 degrees (no two positions being alike) control of inductance, capacity and iron, giving high amplification on all wavelengths from 150 to 750 meters.

A Diesel-Driven Motor Car Ferry for Canada

THE great increase of motor traffic to and from Vancouver Island was the cause of the building of a special motor car ferry which has capacity for 45 motor cars and their passengers. In several ways the design of this unique vessel is exceptional. Cars are carried on both lower and upper deck, and to make the former accessible a ramp was installed amidships which will enable cars to climb to it under their own power. This ferry, which was built at Victoria, B. C., has a length of 170 feet, a breadth of 42 feet and draws 11 feet of water. The hull is of wood.

The propelling machinery consists of two sets of six-cylinder four-stroke-cycle 600-brake-horsepower marine Diesel engines, which on trial tests gave the ferry a speed of 14½ knots per hour. In addition to the accommodations for 45 cars there is a comfortable dining saloon with a maple dance floor so that the passengers can plan their itinerary with a view to dining and dancing while crossing to the island. The ferry is provided with electric lighting, hot and cold water, and heating devices. In general appearance she resembles an ordinary steamer more than a ferry, in spite of the necessity of designing her for a maximum deckload capacity.



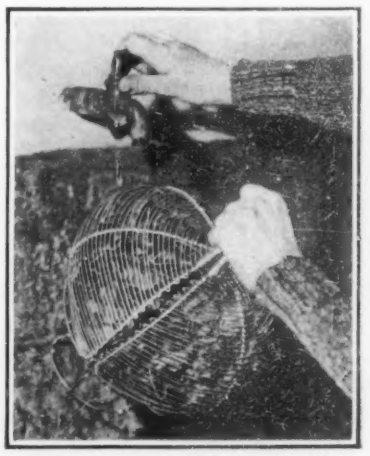
The mathematical chip-stacker

Invention and the Saturday Night Card-Game

INVENTION has removed one of the petty annoyances that beset the poker player. No longer need he wonder how many chips he has, or how he stands on the banker's record; no longer need the superstitious player be annoyed by his neighbor's fingering of his stock to see how far ahead of the game he is; no longer need the banker strike an elaborate trial balance to insure that no extraneous chips are being foisted off on him at cashing-in time; no longer need the chips that were lost on the floor or placed, forgotten, in the pocket of the heavy winner embarrass the business of balancing the game at the breaking-up hour. For the latest chips have a hole in the middle, and are guaranteed all of uniform thickness. Each player has a little tray, with posts for the reds, the whites and the blues; and the accurate marks on these posts, combined with the uniform thickness of the chips themselves, enables every player to know at every moment exactly how many of the "seeds" are stacked in front of him. Incidentally, the perils of the collapse of a lofty stack are also minimized by the new style of banking. Complete sets of chips, posts, and storage box, in every style known to the fastidious poker player, are offered by a leading manufacturer. Incidentally, the back of the box carries a simple peg-and-hole counter by which the banker may score up the chips which he issues to each player, thus doing away with another fruitful source of argument.

A Wire Vegetable Washer

WASHING spinach is a laborious undertaking, and requires the changing of water many times to remove the dirt and sand. Indeed this vegetable is rarely served fresh in hotels, as it takes up so much time of the



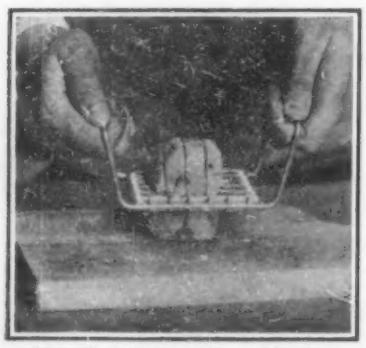
Washing spinach without changing the water

Invention takes the scrubbing pail in hand, with the result pictured

pantry man. With the device illustrated the drudgery of washing spinach, lettuce and other vegetables is reduced to a minimum. The basket is constructed entirely of wire and opens to permit the vegetable's being enclosed. The two handles are grasped with one hand and the basket is placed under a faucet, which soon cleans the vegetable in a thorough manner. This is a valuable addition to the kitchen outfit.

The Thermostatic Solder-Pot

SOLDER must be kept at uniform temperature if satisfactory results are to be obtained. When overheated it oxidizes, and there is a notable loss of material, and of tensile strength by what remains. A solder-pot has been designed to prevent this by means of automatic temperature control. The principle used is a modification of that found in the steam gage. A volatile substance, very sensitive to heat, actuates a Bourden tube which makes and breaks the electric current, thus controlling the temperature of the contents of the pot. Ordinarily the apparatus is so made up that this control goes into play at 600 degrees Fahrenheit. The pot will hold fifteen pounds of solder, and will heat this right up to the dead-line temperature in twenty or twenty-five minutes. This action, quick for an electric heater, is obtained through the working of a 900-watt heating element, built around the entire container. Heat is applied to all parts of the side and bottom of the pot. Once the container is filled and the current turned on, no further attention to the pot is necessary. The current is automatically broken when the heat reaches 600 degrees, and reestablished when it sinks materially below this figure. Workmen may thus devote their entire time to production, without losing any time watching the pot that never boils. The pot weighs but thirteen pounds, and works from 110 or 220 volts, alternating or direct current; hence it is very largely portable.



French fried potatoes without a struggle

My Lady's Scrubbing Pail

THIS might be described as a pail with a college education, for it will do nothing wrong as will the ordinary pail. It is neat and orderly, will not tip over, will not drip on the carpet, will carry soap, brush and cleaning cloths carefully segregated. The pail comes in attractive shades, so as to take away much of the drabness of scrubbing which is the meanest form of housework. The pail is made extra heavy, so that it is not likely to tip over. The pail is securely fastened to a flaring pan which serves to catch any drip and also affords space to tuck in cleaning rags. A regular soap container and a place for the scrubbing brush complete the outfit.

A Novel Strainer

OFTEN vegetables such as Brussels sprouts or mealy potatoes are broken in the process of straining, as this operation is usually done with a separate utensil. With the strainer we illustrate, the danger of breaking the vegetable is reduced to a minimum and the cooked article, be it vegetable, soup or stew, can be strained and the remaining food, after the liquid is poured off, may be put back on the fire in the original vessel to keep warm. A strainer of this kind has more uses in the kitchen than we can enumerate. The semi-circle of tin is punched with holes so that the liquid will run through. The outer edges are well reinforced so that the utensil will last a long time.

A French-Fried-Potato Machine

FRENCH fried potatoes are deservedly popular, but are usually served in hotels and restaurants rather than in the home. The reason for this is that there is considerable art in cutting potatoes into the long strips with square or rectangular section. With the aid of a special cutter like the one we show, there is no difficulty in producing a perfectly formed slice ready for the hot fat. A heavy wire frame holds together a sharp tin grid adapted to divide the potato, vertically, into sections. Various patterns are provided so that any size may be produced. The peeled potato has the bottom cut off so that there is a flat surface in order that it will not wobble when the cutter is forced down through it. The cutter is seized with both hands and is forced slowly and firmly through the potato until stopped by the cutting board. Like so many of these ingenious kitchen appliances, it will save its cost in a short time. It comes from France.

The solder pot that will not burn its contents

A Boiler With 1200-Pound Steam Pressure

A BOILER capable of producing 1200 pounds steam pressure, said to be the highest steam pressure it has ever been attempted to put to practical use, will be installed in a huge power station now being constructed at Weymouth, Mass., for the Edison Electric Illuminating Company of Boston.

Although generating this tremendous pressure, the boiler will have a heating surface no larger than that of the 375-pound pressure boiler commonly used to generate steam to drive turbines in large power-houses. The heating surface of 375-pound boilers is approximately 20,000 square feet.

The steam output of the high-pressure boiler will be more than 110,000 pounds per hour. In many respects its construction will be similar to that of any other boiler of lower pressure. The tubes or pipes in which the steam is heated over the firepot will be no larger in bore than those ordinarily used, but will be somewhat thicker in order to withstand more pressure. The drum or covering in which the tubes will be incased, however, will be a hollow steel forging with walls four inches thick and thereby capable of withstanding extremely high pressure.

A strainer for use with any pot or kettle

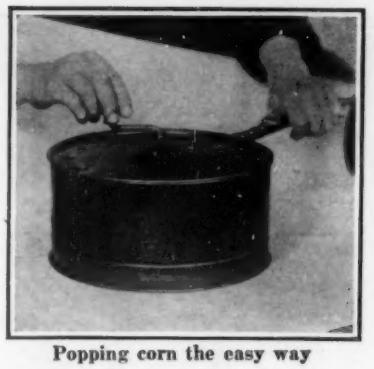
From the tubes or pipes in the boiler, the steam will pass into a superheater made of another series of pipes and placed between two groups of regular tubes in such a way that they are surrounded by terrific heat and a steam pressure up to twelve hundred pounds is generated.

Whereas the steam generated in the customary 375-pound power-house boiler is discharged into a single turbine, the steam from this high-pressure boiler will go through two turbines, being twice expanded and used instead of once. It will first pass through a special turbine capable of taking the 1200 pounds pressure. Then it will be brought back to 375 pounds pressure by passing through another series of pipes in the boiler—this series is known as a "reheater"—and go into an ordinary turbine designed for operation in the ordinary way under that pressure.

Without employing the "reheating" plan used in this boiler, the most advantageous steam pressure, both practically and economically, according to noted steam engineers, is about 375 pounds. Larger pressures have been experimented with heretofore in various countries but were found impracticable, because of technical reasons, for the increase in pressure did not bring a corresponding increase in the amount of electricity generated by the turbine into which the steam passed.

However, when the steam is passed through two turbines, as is the case with this boiler, the high pressure is practicable.

The engineers who worked out the plans for the high-pressure boiler calculate that it will produce with 13,600 tons of coal the same amount of power produced by a 375-pound pressure boiler with 15,100 tons of coal, a saving that will aggregate many thousands of tons in the course of a year. If the boiler proves a success—and the engineers have great faith in its ability to do so—several similar ones will be installed in the power-house.



Popping corn the easy way

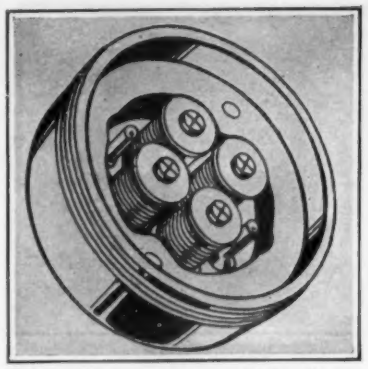
The Rotary Corn-Popper

AMONG the pleasing household novelties offered this season is the corn-popper illustrated herewith. The customary shaking of the old-fashioned popper is replaced by a rotary motion of the handle, which is easier on the user and more effective. This popper will work on gas, kerosene or wood stoves. The operation of the popper is so satisfactory that over 800 were made and sold privately in the inventors' home town before it was put on the market commercially. The secret of good popcorn is claimed to lie in the action of the paddle, a member shaped somewhat like a propeller blade, and attached horizontally to the inner end of the vertical shaft, half way between the top and bottom of the container. Rotation of the handle rotates this, and keeps the corn in constant motion.

A Three-Color Signal Lantern

THERE are often places where a visible signal giving information by colors is useful. We find at railroad stations white, red and green lanterns all carefully trimmed and awaiting an emergency. There are other places where a safer if less robust light is required. A safe lantern to use around a garage or where there is gas or inflammable vapors is very desirable and we have received such a lantern from a concern in Colorado. There is no iron or steel used in the construction so there is no danger of a spark. The rubber-covered handle is secured to a canister which carries a large dry battery connected through the medium of three switches shown to the left with three small incandescent lamp bulbs showing red, white and green. These can be flashed on singly or all may be turned on at will enabling various combinations of signals to be displayed. A heavy wire frame protects the delicate bulbs.

Three-way signal lantern that carries its own battery



Internal arrangement of the four-spool headphone

Four-Pole Headphones

THE true index of power of an electromagnetic device depends upon the number of ampere turns embodied in the windings. It is therefore evident that, by using a round four-pole construction instead of the standard two-pole rectangular cross section, almost twice the number of turns may be got into a radiophone in practically the same space while equal ohmic resistance is retained. In addition, there will be a more uniform magnetic distribution on the diaphragm. The windings of the four-pole phone developed in accordance with this argument are of the spool type. This, with the fabric insulation in the bottom of the case, is claimed to make grounding of the case or coils impossible, so that this phone will stand a higher voltage than any other instrument. The claims are also advanced that this phone is especially sensitive to the weakest signals, that it gives true tonal reproduction under varying conditions, that tube noises and strays are almost entirely eliminated, and that the phone stands the highest amplification without distortion of sound while operating at highest efficiency.

Portable Electric Bench-Lathe

ENTIRELY self-contained and portable, with motor built into the head-stock, the lathe illustrated herewith requires only an electric outlet somewhere in the vicinity to make it possible to set it up and use it anywhere. It is claimed to be unusually accurate, and to handle work with exceptional rapidity. It clears five inches over the tool rest and seven inches on the face plate, while between centers any adjustment up to twenty-four inches is available. The equipment includes the motor, two tool rests of six and twelve inches respectively, head wheel, face plate and cord of good length for attachment to any lamp socket. For serious work making the demand of portability, as well as for the use of the handy man about the house, it seems that this little lathe ought to fill a large place.

A Refrigerated Rolling Pin

IN making fancy pastry it is often necessary to have the crust very thin and flaky and this can be accomplished by the aid of a hollow glass rolling pin which is filled with ice water. A metal cap at one end of a handle permits the rolling pin to be filled with ice water. The use of such a pin will help the baker of toothsome dainties, such as "Napoleons" and other pastry specialties. A glass or porcelain rolling pin is far more sanitary than the old maple rolling pin.

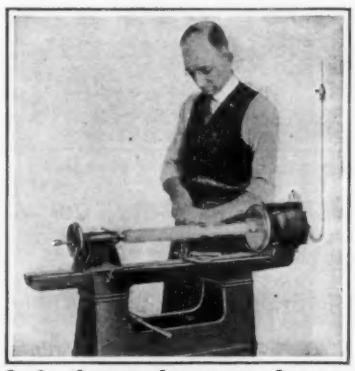
Machine for Wrapping Coils of Wire

A MACHINE that wraps coils of bare or insulated wire with paper has been developed by a Chicago manufacturer. The machine is motor driven by gear and pinion. Drums or sheaves revolve at the proper speed so that the coil is advanced while the shuttle applies the wrapping. The shuttle is driven by a belt and the drums are adjustable to accommodate various sized rolls. These drums also move upward and downward by means of a crank so as to properly center the coil.

In wrapping with paper the exposed edge is turned under a quarter inch so as to give strength where it is needed the most. This is done by an edge-folder through which the paper passes before it is applied to the coil. So that a tight wrap may be obtained, the shuttle is equipped with a tension device through which the paper passes and this offers resistance to the paper as it is applied, drawing it as tightly as possible without breaking.

Honey-Water as a Non-Freezing Engine-Cooler

DURING last winter practical automobilists and truck drivers in five different States made careful tests with a simple mixture of honey and water used as a cooling medium in the automobile engine, and, without exception, pronounced it superior to the alcohol and other non-freezing solutions they had tried. The tests reported were made in Illinois, Ohio, New York, Vermont,

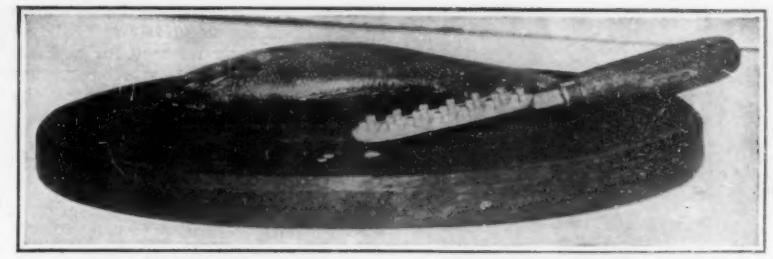


Lathe that can be set up wherever there is current

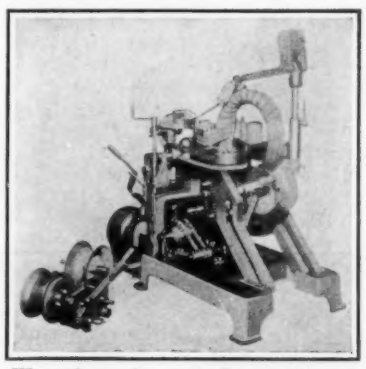
and Wisconsin, all of which States have severe winter weather.

The honey-water generally used—a half-and-half mixture—does not boil until a temperature of 220 degrees Fahrenheit is reached, thereby ensuring a cooling by conductivity, instead of by radiation, for eight degrees above the boiling-point of water, and thereby also lessening evaporation. The boiling-point of the alcohol mixture is below that of water.

When the honey-water is boiled, only the water evaporates, the honey remaining behind unaffected. The percentage of honey in the solution remaining is thereby increased, and the freezing-point is correspondingly lowered. The contrary is true of the alcohol solution: the alcohol evaporates before the water does and the freezing-point of the remainder is raised. And since the honey does not evaporate, little, if any, need be added after the cooling system of the car is first filled at the beginning of the winter season, the only care being that of keeping the system supplied with water as often as it is needed. The alcohol mixture must be tested occasionally and more alcohol supplied to make up for loss by evaporation.



The fish scraper that prevents the scales from flying



Wrapping wire coils by machinery

An estimate may be easily made of the cost of the honey required for a radiator of known capacity. It is only necessary to know the capacity in gallons and to allow one gallon of honey for each two gallons of radiator capacity, if a half-and-half solution is to be used. This gives a mixture a trifle richer in honey than in water, as honey weighs about 12 pounds to the gallon. The present price of good extracted table-honey varies considerably in different localities, probably ranging from 10 to 15 cents a pound in bulk; however, the cheaper grades serve in the automobile as well as the best. But whatever grade is used should be well ripened; that is, it should have been left with the bees until they have had time to thicken it well, during which time certain enzymes will have changed its sugar content from sucrose to invert sugar; therefore thin or fermenting honey should not be used.

A complete union of the honey and water is said to be essential. And since they do not unite readily when cold, the desired result can best be attained by first heating the water and then stirring the honey into it, after which it should be boiled for several minutes. If straining is necessary, nothing is better for the purpose than a piece of wet flannel.

Illinois experiments showed that equal proportions of honey and water united by boiling formed a mixture that did not lose its fluidity until a temperature of two degrees below zero Fahrenheit was reached, at which point it assumed a mushy condition; and that a solution containing 66 per cent of honey did not freeze at 12 degrees below.

The Safety-First Fish-Scaler

EVERY house-wife has had the sad experience of scraping scales off a fish, only to have them fly all over the premises. This will not happen to the up-to-date lady of the kitchen, equipped with the fish-scraper illustrated. The knife is so designed that instead of flying off at a tangent, the scales can only roll quietly out under the knife and play dead on the table. The teeth are blunt, so that they do not cut the flesh of the fish; but they are claimed to take off the scales like magic, in half the time required with more ordinary means.

Grafting Cotton on Mulberry Roots

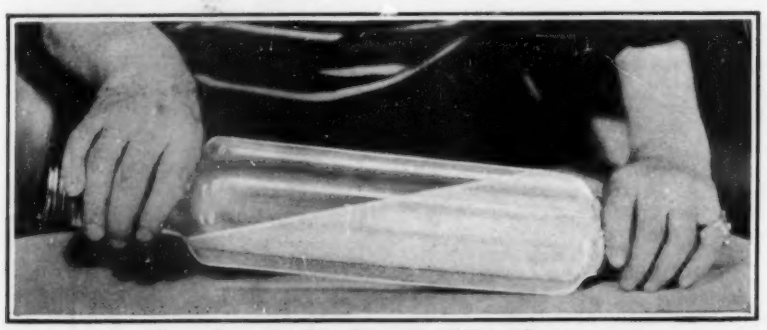
A MULBERRY tree with cotton grafted on its roots, at La Marque, Texas, is growing and renewing growth each year as if it were part of the tree.

This unusual feat in plant grafting has been performed by P. Dan George, a farmer of foreign birth. Dr. E. P. Humbert of the Texas Agricultural and Mechanical College confirms the statement that there is a real union between the cotton plant and the tree. This connection has been maintained for two and a half years and this year the grafted cotton plant yielded nearly a thousand bolls of cotton—a yield many times greater than that of an ordinary cotton plant.

The grafted cotton plant having been converted into a perennial, puts out new growth from the crown each year. During the winter the plants are protected by a covering from the cold. Nothing was noted by Dr. Humbert that indicated that the cotton was undergoing any marked change because of its union with the mulberry root. Difficulty has been experienced in getting the seed of the plants to germinate, only two seed having reproduced.

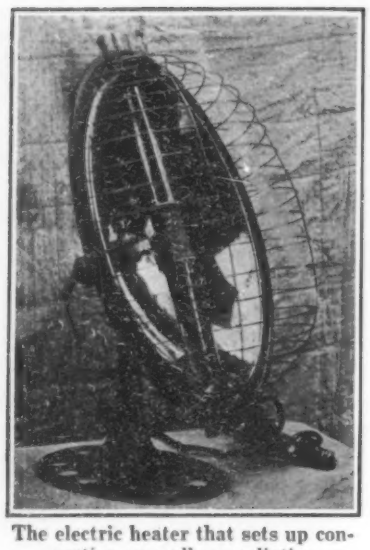
A Gigantic Tea Ball for Cooking Rice

ANYONE who has ever cooked rice remembers what difficulty is experienced in keeping the rice from sticking to the pot, and the grains sometimes even burn. To obviate such troubles a manufacturer has conceived the idea of cooking rice in a gigantic tea ball which cooks the rice perfectly without the grains roaming around the pot. When



The rolling pin that does not stick to the pastry

Borrowing an idea from the tea ball for cooking rice



The electric heater that sets up convection as well as radiation

the rice is cooked the ball is opened and if the quantity was correct, there will be a perfect rice ball all ready to serve with a curry or with Chinese sauce. The size of the ball is so large that it really seems like a Gargantuan tea ball. It is a very useful addition to the kitchen equipment.

Shock-Proof Glass

AN American optical instrument company, which during the world war threw off the foreign dominance of the optical glass industry, has announced that in its own glass furnaces it has obtained a product that withstands great shocks and blows and which is recommended for goggle lenses. This glass is as thin and transparent as usual lenses.

The Bureau of Standards in Washington recently completed comparative tests which show that it is far superior to preceding types of goggle glass. Samples of the new material successfully withstood blows of 2.95 foot-pounds, produced by dropping a steel ball 1⅜ inches in diameter from a height of eight feet. In all cases, even when finished in ways which reduced its possible strength, the new product withstood at least 1.30 foot-pounds, or five times the previous maximum. As indicated by the results of these tests the new glass is a superior product for safety goggles.

The All-Around Angle Tool

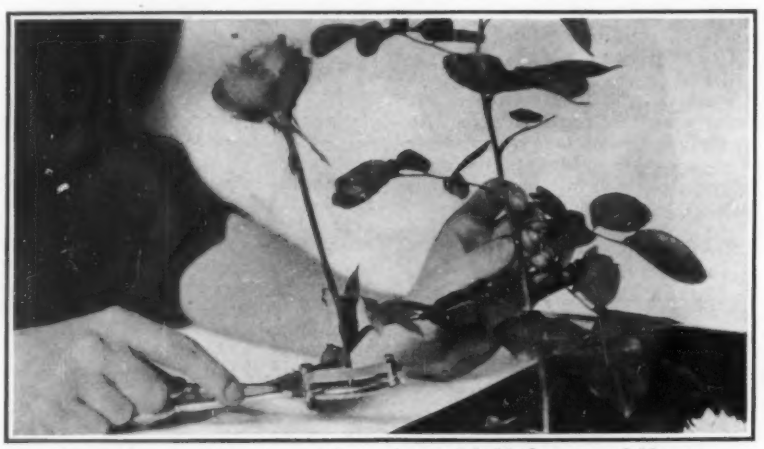
COMBINATIONS of try-square with other tools are nothing at all new, but the one illustrated on this page, it is claimed, goes far beyond any of its predecessors in usability. In addition to its obvious function as try-square, it is designed to serve as miter square, octagon, bevel and protractor. In connection with its use as miter, bevel or octagon, it has five positive adjustment angles on each side of the 90-degree angle, at each of which it is rigidly locked by the (automatic) engagement of a pin in a hole.

The try-square of many uses

On these adjustments, the blade stands rigid without the slightest "waggle"; yet it can be instantly released for new adjustment by a slight thumb pressure upon the push button. For carrying, the blade may be alined with the handle.

Double Duty from the Electric Heater

SOMETHING new in the application of electricity to heating problems is offered by a New York manufacturer. Instead of relying solely upon radiant or reflected heat, which is ineffective so far as raising the room temperature is concerned, it employs simultaneously the three principles of radiation, conduction and convection. In the first place, the heating element is hollow, like a gas retort with both ends open; and copper tubes are attached at top and bottom, converting it into an elongated flue, which is placed vertically within the body of the apparatus at a suitable distance from the reflector. As the inner walls of the heating element became hot, they super-heat the air within this cylinder; and this air is naturally expelled at the top of the tube, while cool air is drawn in at the bottom. This circulation once set up, is continuous. The reflector has been made oval rather than circular, for the purpose of accommodating a heat tube of greater length. As a result of all this, there is not merely a blast of radiant heat passing across the room and heating persons, walls, etc.; but there is continuously discharged into the atmosphere of the room, by convection, a current of heated air, while there is considerable ordinary conduction of heat from the copper through the air.



Flower shears with grippers that seize and hold the severed blossom

Roads From Clover and Sawdust

IT is reported that an experiment in road-making in a sandy district in Minnesota has proved successful. This road was constructed by employing a mixture of freshly cut yellow clover and rye straw with the sand base, the idea being to convert the sand into a vegetable loam so that it might be worked into a road. The highway has been in use for some time and is highly praised by the farmers who use it.

In some portions of the State, the sandy nature of the soil makes good roads out of the question without the importation of surface materials. In most cases this is impossible by reason of the expense. So there was evolved the idea of changing the character of the soil along the highway by mingling it with vegetable matter. In one place clover was used, and on a shorter stretch sawdust was employed as the road-making ingredient.

For the clover road the road was graded and planted; on the right-of-way was yellow clover and rye, except for a driveway of 20 feet. The rye was planted with the clover to protect the latter during the summer. Rye straw was thrown on the road and worked into the sand by passing vehicles. Several times during the summer the clover was cut and also thrown upon the road. This was well worked into the sand and has partly changed the character of the soil, getting away from the difficulties of a sandy road.

Four inches of sawdust from a sawmill was spread over a quarter of a mile of road near another place and worked into the sand in a similar manner. The top of the roadway was frequently worked so as to prevent ruts and the sawdust was well mixed with the sand. This is rotting and is gradually making it possible to work the road as if it were made of loam.

Rose Shears

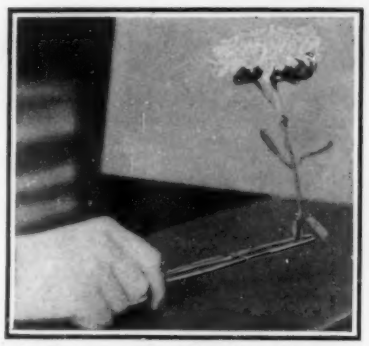
ORDINARY scissors are, of course, perfectly well adapted to cut flowers, although gardening shears of greater strength have been recommended and sold. If the plant or bush is high, the flower is apt to drop to the ground after the stem is severed. We show two special forms of shears which cut and hold the stem at the same time. In the first one, when the blades antagonize, an extra lug on one blade holds the flower until the shears are opened. In the other the same effect is obtained by means of two springs which snap against the stem and hold it securely until released.

The Scalp Massage Bottle that Rubs It in

WHEN you purchase a bottle of scalp remedy the directions practically always tell you to rub it into the scalp. This advice is excellent, but people do not follow it very long. It is human nature to rub it in for the first few days, after which the original enthusiasm wanes and the user compromises by applying the liquid without applying the exercise. This may do some good—or it may not. The massaging is very beneficial, probably accounting in some cases for fully half of the good results obtained. It loosens the scalp, causes the blood to flow through a million capillaries and releases dandruff and scale. How, then, to get people to massage the scalp? A Chicago manufacturer of hair remedies has come forward with a simple solution of this problem. If you can't reform human nature, then reform the bottle in which the hair remedy comes. Make it necessary in order to get the liquid to flow, to massage the head with a rubber device attached to the bottle. The bottle in question has a large rubber cap from which project several rubber nipples through which the scalp liquid oozes as the scalp is rubbed. If you have no hair, if you have little, or if you have some scalp disease like dandruff or "scaliness" one minute's rubbing per day for a month or two with this remedy will probably produce surprising results. You may then discover a very fine thin crop of fuzz, at first observable only under favorable light. Of course, if you can get fuzz you ought to be able to get hair, for that is proof enough that the roots of the hair are not dead, but have merely been dormant.

One of the chief causes of falling hair is the excess of fat secretion from the sebum glands, one of which lies at the root of each hair. This fat, called sebum, becomes caked, forming little round plugs in the follicle, which close so tightly around the base of the hairs that they break off and fall. When a remedy that is beneficial to the scalp is applied daily with the bottle that rubs it in, these little plugs of hard matter are loosened, the follicle is thus opened, and if the stimulating rubbing treatment is persevered in daily you are at least on the road to hair again.

Sometimes the roots of the hair have died. If this is the case there is no hope. But in the majority of cases of baldness, even if there has been no hair in years, the roots still live. In such cases the fuzz will appear, generally within a month or two, in some cases sooner, and the rest depends upon the enthusiasm of the user and whether he massages the scalp with the bottle every morning, making it a part of the shaving ritual, or merely does it only once in a while. New hair cannot be easily earned. The manufacturer of these massage bottles sends them out filled with several kinds of liquid, for the treatment of dandruff, falling hair, scaliness, etc. Each condition demands a separate remedy. It is a relief to find a remedy for baldness that does not necessitate one's going about smelling like a tar barrel.



Another way of keeping the cut flower from falling to the ground

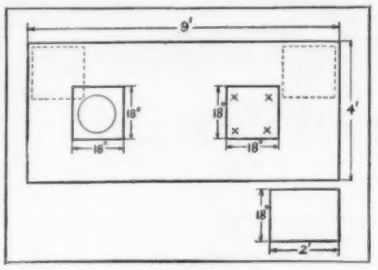
To get the massage fluid to flow from this bottle, the motions of rubbing it in are necessary

Our Psychic Investigation Advances

(*Continued from page 86*)

tion, contributing added certainty that he had enough freedom of chest and shoulders to get the right arm out of the glove and sleeve. The left arm, obviously, unless something were broken or untied, would have to work from *statu quo* and through the glove in any contribution it might make to the action of the seance.

Thus secured, the medium was placed in the cabinet, at the right (*i.e., his* right as he faced the sitters). At the left, and some 4 feet distant, was another chair with tambourine, trumpet, whistle and two bells. Outside, at the left and touching the curtain, stood a small deal table. Palladino came with unusual promptness; the doctor had difficulty with her hoarse whisper, but finally gathered that she wanted the medium in the corner. He and I therefore entered the cabinet and placed both chairs more closely into their corners, as indicated in the diagram on this page. Palladino then spoke in better voice, and made clear her desires; in accordance with these, we moved the medium to the left side of the cabinet and placed the other chair at his right, half a yard or so from him. This meant that the apparatus was on the same side as his potentially free hand, and that both it and the table were much nearer to Nino than at first. The second diagram makes all this clear.

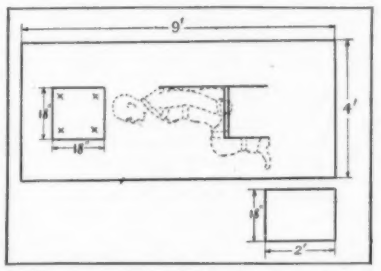


The chair with the circle is that occupied by the medium, that with the crosses the one containing the apparatus. The full squares indicate the original positions of the chairs, the dotted ones their places after the first rearrangement

Early condition of the cabinet at the initial seance

For 24 minutes after this we had nothing but conversation, with repeated demands that we talk among ourselves. Then the physical phenomena commenced, with raps. After quite a display of these, we had a nine-minute hiatus, with talk and scraping of the chairs in the cabinet; then the bells came into play, and rang very freely. The trumpet was next used to tilt the table, to stroke the curtains, and finally for a short bark of inarticulate voice. The tambourine and both bells operated simultaneously, being followed by a very finished act in which they and the trumpet, four in all, were used in succession at short and uniform intervals. The whistle came into play last, very loud and shrill.

This brilliant phase lasted 12 minutes, being followed by 15 minutes in which there came from the cabinet only demands that we talk and sing. While responding to the latter request, we got a fresh shower of raps, bells and tambourine, in time with the song. A further wait of ten minutes was terminated by a crash in the cabinet, with distressed cries for aid. We found the chair with Nino in it, capsized on its side; and in going over, he had struck his head on the other chair, so that his nose was bleeding freely. We righted him, and found him in such hysteria that it seemed imperative to cut him loose without delay.



The position in which the two chairs were found at the end of the first sitting, with the medium prostrate

Superficially I was able to examine the bonds as we cut them; they seemed little disturbed, with one important exception. The wire about the forearms had been anchored to the upper arms. At the left this anchorage had not been tampered with; on the right it had been loosened and slipped down to the elbow. Perhaps this was accidental; but I judged that until the wire was thus eased, the arm could not be sufficiently straightened to be withdrawn from the sleeve.

Both bells showed finger prints; no teeth marks were found on any of the apparatus.

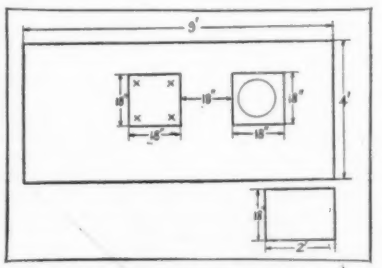
On the 14th we paid less attention to the wire about the forearms, concentrating upon so arranging the ropes about the arms and chest as to assure a minimum of mobility of the shoulders. We sewed the left glove to the coat sleeve and the right to the shirt, and put the apparatus at Nino's right. Recalling the first seance, a request for transposition might have been expected; but it did not occur.

The cabinet was only five feet wide this time; by special request of Dr. Vecchio it was covered across the top, at a height of six feet. I ought perhaps to explain that "cabinet" is a technical term of the seance room; it denotes, not an article of furniture, but merely an enclosed space at one side or corner of the room. Ours is made by pinning black cloth over a sectional wooden framework.

The way the triangular cabinet was set up for the third seance

The initial period of inactivity was this time 26 minutes. It was less occupied with conversation from Palladino, and there was less creaking of the chair. A demand was made that three of the sitters, who were quite close to the cabinet, be withdrawn to a greater distance. When the demonstrations began, they occurred to a considerable extent upon the table outside the cabinet; there was never enough light to furnish observations of value here, however.

At one time a bell was placed upon the table, and fell to the floor outside the cabinet. I replaced it on the table, and it was later taken back into the cabinet. The tambourine was placed on the table, and covered with the trumpet. The table itself tilted sharply and repeatedly, and was turned about and left at an angle with its original position. In other details, the sitting was substantially a repetition of the first one.



The final arrangement at the first seance, which prevailed throughout the active phase

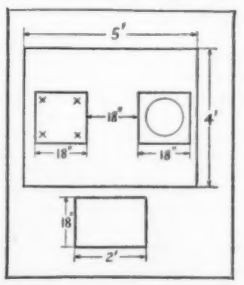
Dr. Vecchio was positive that he saw a hand outside the cabinet. One or two others were inclined to verify this in part, though unable to identify the object as a hand. Dr. Block thought it a shadow passing over the cloth. Most of us saw nothing.

At Nino's informal sittings it is customary to get hand-clapping. On Monday and Friday, Dr. Vecchio asked for this repeatedly, sometimes setting the example with his own hands. At no time was the request honored, though everything else that he asked for was given. In view of the known improbability that both of Nino's hands could be normally free, this omission seemed significant.

The violent phase of the second sitting lasted for 20 minutes, with slight interruptions. It was succeeded by a period of inactivity during which we got nothing save Palladino's voice. After 61 minutes of this, she finally permitted the sitting to end in accord with Dr. Vecchio's reiterated demand. But first she called him to the cabinet and whispered to him that the medium had been very restless, and that we should find his bonds seriously disturbed.

This was putting it mildly, as the photographs indicate. The wire about the forearms had been so displaced that all the loops save one were now about the right wrist alone. The one loop which had resisted this treatment remained to act as a pivot, about which the arms could play like scissors, giving a wide range of movement for both gloved hands.

The most desperate attempts had been made to free a hand. Mr. Hopkins had to take his overcoat to the tailor next day to have the left cuff repaired where it had been chewed as though by a teething puppy. At the right, the coat sleeve had been drawn back and the undershirt similarly chewed where it joined the glove. Both gloves were saturated with saliva. In both gloves the lining, which was separate from the outer shell, had been turned partly inside out; similarly with the thumbs, and it had been found impossible to return Nino's thumbs to their stalls. The conclusion from all this that it had been impossible to free a hand was borne out by the failure of any of the apparatus to show finger prints. The performance, if not genuinely psychic, had been engineered with gloved hands, brought into play by hitching the chair from point to point in the cabinet.



The arrangement of the smaller cabinet for the second sitting

For the third sitting we planned something not yet tried—a definite attempt to fix the medium so that he could effect no escape whatever in normal fashion. We made this attempt under the best of auspices; Houdini interrupted a vaudeville tour and came on from Little Rock, Ark., to superintend the tying.

For the disposition of the hands we used the gloves again, but sewed them both to the undershirt. Then we forced each sleeve down over the other hand, and sewed the two sleeves firmly together. The linings of the gloves had been sewed to the outer layers at the tip, and the thumbs tacked down against the bodies. The coat was a suit coat rather than an overcoat, and the gloved hands packed the sleeves so tightly that Nino could plainly get no action with his hands unless he burst the sleeves. The coat was sewed snugly about the neck, and at the two front corners and in the middle of the back was basted to the trousers.

With the soft rope supplied him, Houdini personally tied Nino into the chair, and he did a masterly job. In every case he made a loop about the arm, leg, chest, etc., and tied this with a square knot, leaving ends long enough to form a second loop to pass about the appropriate portion of the chair. Drawing the former loop only so tight as was comfortable for Nino, and the latter as tight as it could be drawn, a maximum of security was obtained without hurting Nino in the least—unless he was going to struggle to free himself, in which event he could make himself acutely uncomfortable.

The medium's chair was tied to the base-board of the cabinet with a loop of metal strap, a cord, and a wax seal. The chair could not be displaced without breaking the seal, and this could not possibly be done by accident. Securing the chair in this fashion made it unnecessary to discommode Nino by fastening his feet clear of the floor, as would have been necessary otherwise; for with his feet on the floor and the chair free, he can move the chair anywhere he pleases.

The chairful of apparatus was placed in front of the medium and 20 inches distant. We sat for 81 minutes, and with the exception noted below nothing occurred save conversation from Palladino. She wanted us to talk and sing, as usual. Now she praised the skill with which we had tied the medium, and again she complained that he was very uncomfortable. Houdini resented this, and I had to restrain him from arguing it with her. Later he did argue it with Dr. Vecchio, insisting that so long as no attempt was made to get free, the bonds were as comfortable as bonds could reasonably be. I agreed with him. If we cannot tie the medium effectively without stopping the phenomena, let us have this understood once for all.

Throughout this sitting the cabinet gave off intermittently sounds like those from a chair that stands unevenly, tilting back and forth from three legs to another three. Sometimes this was accompanied by slight disturbances of tambourine or bells, identifying the affected chair as the one carrying the apparatus.

When we entered the cabinet at the end, we found that the second chair had been placed in contact with the baseboard at the back of the cabinet, and that Nino's foot could be twisted into contact with this same baseboard. We demonstrated experimentally that a noiseless application of the foot to the board would rock the chair and duplicate the noise we had heard; and we observed marks on the board indicating that the foot had been applied to it. Even Dr. Vecchio accepted this explanation, and agreed that nothing supernormal had been heard.

Examination showed conclusively that the medium had attained no freedom, though sounds from the cabinet indicated attempts to do so. Houdini had not underestimated the difficulty of tying a strong and active human; he had said that he wouldn't guarantee that Nino couldn't get loose, but he would guarantee that he would never get back. He had not got out at any point, however; and there had been so physical

(*Continued on page 133*)

Recently Patented Inventions

Brief Descriptions of Newly Invented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Apparel

GARMENT FASTENER.—R. A. NOWAK, 940 So. Bixel St., Los Angeles, Cal. The particular object of this invention is to provide a device that will dispense with the button and buttonhole now commonly used for garment fastening. A further object is to provide a fastener that can be cheaply constructed, and very easily operated. (See Fig. 1.)

Electrical Devices

ELECTRIC MOTOR-DRIVEN COMPRESSOR.—G. J. SPOHRER, 46 E. Eppirt St., East Orange, N. J. This invention is largely used for tire pumping, and makes a distinct development in that it attains a high speed in a compressor. It is constructed to run over 2000 revolutions per minute. One important factor in attaining the high speed, is the absence of bearings on the compressor, the piston thrust being on the bearings of the high-speed motor; this permits of a high-speed drive connection, usually direct, between the motor shaft and the compressor piston.

AUTOMATIC BATTERY WATER-SUPPLYING DEVICE.—A. MENGER, 611 Adams St., San Antonio, Texas. The invention relates to a device which is adapted to be applied to electric storage batteries of ordinary types, such as are adapted for use in automobiles, to automatically maintain the electrolyte in the several cells of a battery to which applied at a desirable level by supplying distilled water to the cells when required. The device may be operatively applied without preventing the inspection or testing of the electrolyte. (See Fig. 2.)

STORAGE-BATTERY FILLER.—C. BURKHARD, 728 Elton Ave., Bronx, N. Y. The general object of the invention is the provision of a simple portable filler which may be used to fill any container with a fluid which will conduct electricity, or to dilute any conducting fluid, the filling means being provided with means for automatically shutting off the filling device when the fluid in the container has reached a certain level.

Of Interest to Farmers

CUTTER FOR FORAGE AND GRAIN GRINDERS.—J. HOCHENAUER, c/o Hochenauer, Alfalfa Mills, Mfg. Co., Pueblo, Colo. The invention relates to that type of apparatus in which a series of cutters are disposed at various angles upon a lengthwise shaft for operation above a semicylindrical screen. An object is to produce a cutter formed of a flat strip of metal with concavely curved sides whereby cutting edges are formed at opposite sides of square ends whereby the number of cutting edges may be materially increased, and the cutting materially enhanced.

POULTRY PERCH.—J. MANCHESTER, North Loup, Neb. The invention has for its object the provision of a device adapted to contain a medicated solution which will saturate the perch to prevent mites or other v rmin from infesting and propagating on the perch. A further object is to provide a longitudinal groove extending from end to end of the bar, such groove being covered so that the disinfecting solution will not come in contact with the feet of the poultry.

BRUSH GRUBBER AND LEVELER.—E. C. LEAK, Susanville, Calif. Among the objects of this invention is to provide a simple, easily constructed, economical device of the character specified, wherein an A-frame is provided adapted to be drawn through the sage brush, and provided with cutting blades on its inclined side for cutting and pulling up the brush.

MOWER.—C. LORENSON, c/o Lorenson Harvester Co., 1314 W. 3d St., Davenport, Iowa. An object of this invention is to increase the mobility of the machine and to enable it to be used where the cutter bar is required to work at various angles relative to the general position of the machine so as to enable the machine to effectively cut grass or vegetation where the slope of the ground, passed over by the cutter bar, is generally unfavorable for cutting, the machine may also be adjusted for topping weeds or the like.

MANURE REMOVER AND SPREADER.—H. C. WRIGHT and W. J. WRIGHT, Dugold, Manitoba, Canada. Among the objects of the invention is to provide a device of the character specified equipped with mechanism for loading manure and also for spreading, and feeding the same to the spreader, the traction wheels automatically operating the feeding mechanism. A further object is to provide means for throwing the traction wheels and feeding mechanism out of gear without spreading manure.

SPRAYER.—J. C. FREDERICK, 1992 Fullerton Ave., Detroit, Mich. The invention relates to agricultural implements. The primary object is to provide a sprayer constructed in the form of an attachment which may be easily attached to and detached from the frame of a cultivator so that the sprayer may find ready use in connection with the cultivation of plants, or the sprayer may be used separately from the cultivator, or other farm tool.

GRAIN SAVER.—C. F. KLUTH, Wibaux, Mont. The invention has for its object to provide an attachment or grain saver for self-binding grain binders and other harvesting machines. A further object is to provide in combination with the platform canvas or apron, or endless conveyer and elevator canvas, a grain saving attachment so as to catch all grain that falls between the platform and the elevator canvases and onto the ground.

FRUIT CATCHER AND GRADER.—J. F. COOK, 846 Brunswick St., San Francisco, Cal. This invention relates to the harvesting of fruit such as apples, prunes, apricots, peaches, and the like which require careful handling. The principal object is to facilitate the gathering in an economical way without making it necessary for the fruit picker to climb the tree. The catcher is portable and is associated with a grader, the fruit being gathered and graded simultaneously. (See Fig. 3.)

THRASHING DEVICE.—H. R. TUCKER, Box 414, Balboa, Canal Zone. This invention relates to a device for thrashing rice, wheat or other grains, its general object is to provide a manually operated device that may be set up in any convenient place, such as on a table, for example; it is designed primarily for use in isolated situations in lieu of the primitive flail. (See Fig. 4.)

5.—WHAT IS INVENTION?

INVENTION is difficult of definition; it is almost always a question of fact. An improvement may or may not be invention; if to devise such an improvement the exercise of the true inventive faculty is required, it is an invention. But the border line between pure invention and the practice of mechanical skill, technical knowledge and experience is often indeed vague. Perhaps the best judicial expression respecting the foregoing is that of Justice Bradley of the Supreme Court, delivered in 1882 as follows: "The process of development in manufactures creates a constant demand for new appliances, which the skill of ordinary head workmen and engineers is generally adequate to devise, and which, indeed, are the natural and proper outgrowth of such development. Each step forward prepares the way for the next, and each is usually taken by spontaneous trials and attempts in a hundred different places. To grant to a single party a monopoly of every slight advance made, except where the exercise of invention somewhat above ordinary mechanical or engineering skill is distinctly shown, is unjust in principle and injurious in its consequences. The design of the patent laws is to reward those who make some substantial discovery or invention which adds to our knowledge and makes a step in advance in the useful arts. Such inventors are worthy of all favor. It is never the object of those laws to grant a monopoly for every trifling device, every shadow of a shade of an idea which would naturally and spontaneously occur to any skilled mechanic or operator in the ordinary progress of manufactures. Such an indiscriminate creation of exclusive privileges tends rather to obstruct than to stimulate invention. It creates a class of speculative schemers who make it their business to watch the advancing wave of improvement, and gather its foam in the form of patented monopolies, which enable them to lay a heavy tax upon the industry of the country without contributing anything to the real advancement of the arts. It embarrasses the honest pursuit of business with fears and apprehensions of concealed liens and unknown liabilities to lawsuits and vexatious accountings for profits made in good faith."

Of General Interest

DISPLAY TABLE.—W. PATTEN, 57 W. 125th St., New York, N. Y. An object of the invention is the provision of means whereby the periods of rotation and rest of the table can be varied at will so that when the articles of merchandise are displayed and mounted on the table their peculiar intermittent motion causes the attention of the public to be drawn more quickly to them.

DISPENSING DEVICE.—S. S. CELANO, 839 2nd Ave., New York, N. Y. The invention relates to a brush such as is primarily intended for use in connection with the brushing of the teeth. It is an object to provide a brush with which a tube of tooth paste may be operatively combined to permit of the substance contained within the tube being applied directly to the bristles of the brush. It is a further object to provide a self-contained and compact device of this character.

CAMPING OUTFIT.—O. E. HANS, Box 202, Paden, Okla. An object of the invention is to provide a camping outfit which is of simplified construction and which will afford sleeping and housing accommodation for a plurality of persons when set up. The device is adapted to be attached to an automobile of ordinary construction in such manner as not to retard the movements of the car, and may be folded into small compass whereby it is readily portable when detached.

TABLE FOR TALKING MACHINE.—J. F. BORST and W. BORST, 1117 Cypress Ave., Ridgewood, Brooklyn, N. Y. It is the primary object of the invention to insulate the diaphragm from friction, vibration and sounds from the sound box and stylus and various metal parts of the machine, by the use of a material the transmission qualities of which are extremely low, thereby leaving the diaphragm free to render a clear reproduction.

CONTRACTED OR SHORTENED CHARACTERS FOR PRINT.—E. R. SANTONI, 11 Via del Comune, Ancona, Italy. The object of this invention is to provide contracted characters for print, the main feature of which comprises a fundamental letter, symbolized secondary letters inserted in the same, and symbolized mobile overhead letters superposed to the same, the secondary letters being in a reduced shape.

BRACELET.—W. SEGMAN, 102 Fulton St., New York, N. Y. This invention more particularly relates to a chain bracelet and has for its general object to provide a chain bracelet which aims to embody strength combined with an attractive appearance yet embodying links of simple form well adapted for receiving stones in a desirable arrangement, the bracelet being composed of elliptical links and intermediate shorter links.

BOOKBINDING.—G. S. FRY, c/o Gregg Publishing Co., 585 5th Ave., New York, N. Y. Among the objects of the invention is to provide means whereby the strain between the boards of the cover and the back of the book is eliminated, the cover being hinged to

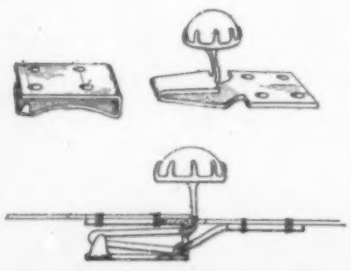


Fig. 1. Something different in garment fasteners, as invented by R. A. Nowak

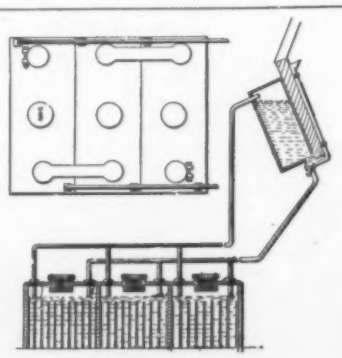


Fig. 2. Supplying battery-water automatically with A. Menger's invention

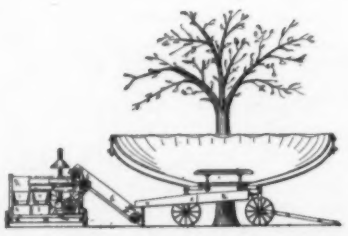


Fig. 3. Portable fruit gatherer and grader, patented by J. F. Cook

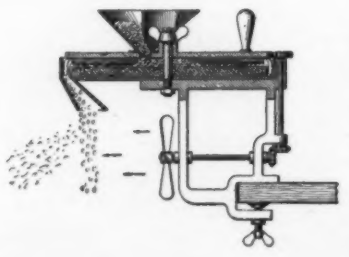


Fig. 4. H. R. Tucker's home thrashing device for rice and other grains

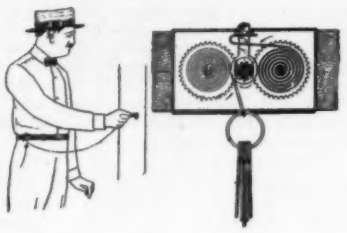


Fig. 5. T. J. Morrison's key holder with extensible chain and reel

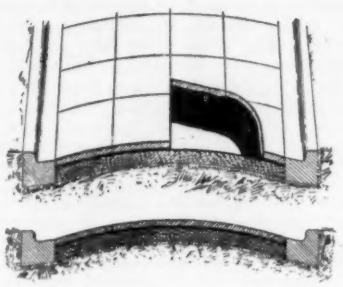


Fig. 6. J. B. Watts' new design for road surface, facilitating expansion

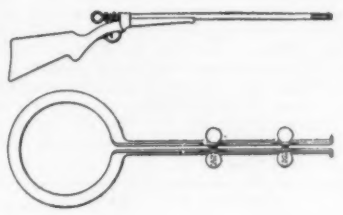


Fig. 7. Combined stop and handle for bore-cleaning rods, the invention of E. H. Williams

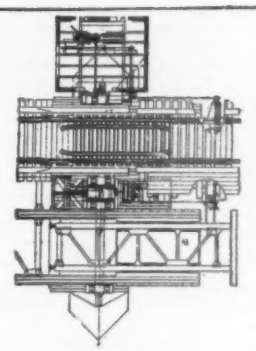


Fig. 8. Novel bridge structure of portable type, patented by S. A. Reake

permit of its being swung completely around beneath the body portion and lie adjacent the other cover portion without any strain whatever on the parts.

KEY CHAIN REEL.—T. J. MORRISON, 367 W. 123d St., New York, N. Y. The general object of the invention is the provision of a compact reel provided with an extensible means for holding keys or the like, that operates to retain the extensible key holding means in its extended position, and that may be operated to draw the extensible key holding means into the casing. (See Fig. 5.)

CONTAINER.—A. H. TRAGESER and L. HASSINGER, c/o Albert H. Trageser, 447 W. 26th St., New York, N. Y. The primary object of the invention is to provide a shipping container particularly adapted for the transportation of heavy fluids such as paint, ink, varnish, and the like, the device being provided with a removable closure plate so constructed that a liquid-tight joint is had between the container and the closure plate.

ARTIFICIAL BAIT.—P. E. PETERSEN, c/o Frank Leveroni, 814 Fremont Bldg., Boston, Mass. The invention relates to an artificial bait made to simulate a minnow, and is equipped with gang hooks and a plate projecting at the under side. The general object is to provide a plate so formed and arranged as to develop the utmost rotary or turning motion of the bait about its axis to produce a rapid wiggling motion approximating the actual motions of a life fish in swimming.

EXERCISING DEVICE.—C. G. PURDY, 151 Linden Ave., Brooklyn, N. Y. The invention is especially designed and constructed for exercising the teeth and gums. The primary object is to provide a device the use of which will supply the necessary exercise to the muscles of these several organs to keep the organs in a healthy state, and operate as a preventive agent and curative medicine in cases of pyorrhea.

PROCESS FOR PRODUCING STEEL.—J. T. JONES, 2032 Greenup St., Covington, Ky. The primary object is to provide a process by means of which a cheap deoxidizing and recarburizing agent may be used to obtain a product of the highest grade, tool, or armor plate, steel. A further object is to provide a process whereby iron of a fibrous nature, such as wrought iron, may be treated so that the surface may be rendered extremely hard, the hardness decreasing toward the center. The process comprises treating the surface with material comprising molten pig iron containing carbon in a combined state.

ARTIFICIAL BAIT.—G. E. FENNER, c/o J. E. Wall, Oxford, Wis. This invention relates to a fishing bait in which the hooks are ordinarily guarded and the barbs thereof covered to prevent the bait from catching on weeds, but in which the hooks become automatically exposed to hook into the fish, upon the bait being taken by the fish; the device including means that will instantly return the hook to protected position without action by the fisherman.

MOTHPROOF CHEST.—W. C. DEISS, c/o J. C. Roeser, 156 Broadway, New York, N. Y. The invention has for its object to provide a device in which clothing or other articles may be conveniently stored, and which may be closed as to effectively prevent the entrance of moths, or which may be treated in such a manner as to be repugnant to moths. The device is strong and durable, and may be collapsed for the purpose of storage or transportation.

LINE FASTENER.—H. C. LAFFERTY, Box 156, New Castle, Pa. This invention relates to means for fastening a clothesline, guy rope, or the like, and more particularly to a fastening device of the hook type having means for suspending it in position and for so engaging the rope as to hold it fast but permit of the rope being readily loosened with the greatest facility when desired. A further object is to provide a line fastener that may be either hung on a fixed hook or applied as a connection between terminals.

PEEP SIGHT FOR FIREARMS.—J. C. MATTHEWS, Kamiah, Idaho. An important object is to provide a peep sight which may be rotatably adjusted for accuracy in aiming when firing at different distances. A further object is to provide a sight which may be attached to any firearm without changing the construction of the same. The device consists of but few parts, yet is efficient in operation.

FORM FOR CONCRETE CONSTRUCTION.—C. W. HAYWARD, 926 E. Guitterrez, Santa Barbara, Cal. The aim of this invention is to provide a device which will require very little lumber and time for its setting and which will furnish a form for continuously constructing a concrete wall whether hollow or solid and in which the wall may be progressively advanced in height by the repeated application of the given number of boards throughout various stages of the building of the wall.

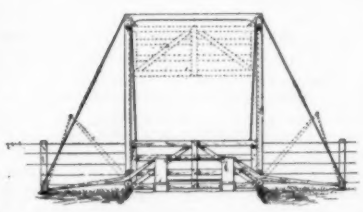


Fig. 9. G. H. Knutson's self-closing gate, operated by the weight of the passing vehicle

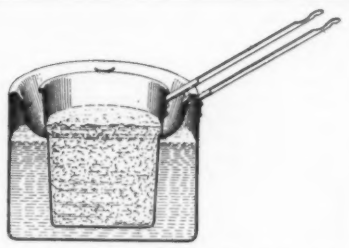


Fig. 10. A better double boiler designed by J. R. Smith

CLASP FOR BRACELETS.—K. L. TOELCKE, A. MIKKOLA and L. SHAPIRO, c/o Master Jewelry Co., 57 E. Jackson Blvd., Chicago, Ill. An object of the invention is to provide a clasp for a bracelet or the like that securely locks the free ends of the bracelet against unintentional separation from one another. The device is constructed to resemble the ordinary link of the bracelet and therefore not contrasted against the general design. Means are provided for releasing the lock, but it is not likely to become accidentally actuated.

OPTICAL BINOCULAR INSTRUMENT.—E. WESSELY and J. SCHIER, c/o Paget Moeller Hardy, Vienna, Austria. The object of this invention is to provide a binocular official instrument for inspecting narrow cavities which is simple and cheap in construction, which can be readily cleaned and sterilized and in which the rays of light coming from the object to be inspected enter the two eyes of the observer of an angle of divergency greater than that at which they come from the object.

KNOCKDOWN TABLE.—W. SCHWAEGLER, 1462 Edgewater Ave., Chicago, Ill. An object of this invention is to provide a knockdown table which may be readily assembled and disassembled without the use of tools or the like, and when disassembled may be packed in a relatively small space. A further object is to provide a table in which the legs can be secured so as to produce a light, strong and durable structure, not likely to easily get out of order.

HAND BAG.—I. C. BLUMENTHAL, 62 W. 113th St., New York, N. Y. This invention has for an object to provide a construction which is very simple but which will act as a proper enclosure while presenting a locking and supporting means. A further object is to provide a hand bag with supporting and locking straps arranged to pass beneath the lower edge of the bag and to a point above the bag so as to support the bag and its contents at the same time lock the upper part of bag.

COUPLING.—E. G. JOHNSON, c/o, Stuart-Johnson Co., Hibbing, Minnesota. Among the objects of the invention is the provision of a device for easily and rapidly attaching a hose to a fire plug, whereby firemen will not lose any time in getting their equipment ready. The attachment is capable of being locked against manipulation by unauthorized persons. A further object is to provide cooperating members which may be automatically connected and sealed to prevent loss of water.

BUILDING BLOCK.—G. EY, 307 E. 87th St., New York, N. Y. The general object of this invention is the provision of a simple and durable block so designed that, when subjected to a breaking strain, the line of break is long in comparison to the dimensions of the block. A further object is the provision of a block in which the web and bracing members joining the side walls terminate in a plane extending at right angles to the side walls so that the line defining the junction of the ends of the bracing members and web with the side walls is straight.

TANK CONSTRUCTION.—S. DIGGLE, R. F. D. No. 3, Hempstead, N. Y. The invention aims to provide a construction which materially increases the pressure load resistance, which reduces the areas of the plate members and segregates the same, which relieves the walls or sides from the roof-load stresses, which facilitates the process of welding the elements together, and which effects an economy both in materials and labor, while at the same time increasing the efficiency of the structure.

LIGHTNING ROD.—M. CREIGHTON, Rensselaer Falls, N. Y. The invention has for its general object to provide features which constitute a connector between the point element of the lightning rod and the conductor cable, as well as means to secure the point element in position on a roof or the like in a manner to sustain the connection and cable raised and amply protected against the ingress of rain, with the possible result of affecting the electrical connection, due to freezing.

SOAP DISPENSER.—L. S. ROSENBERGER, Fox Chase, Philadelphia, Pa. The object is to provide a construction which may be readily mounted in a horizontal plane and in such a manner as to discharge the soap at a desired point, intermittently. A further object is to provide a device in which the soap is propelled and forced toward the opening, thereby insuring a sufficient discharge to answer the requirements of the operator.

DEVICE FOR USE IN MENDING FILMS.—R. G. WYMAN, 424 Dahill Road, Kensington, Brooklyn, N. Y. This invention relates to a device for use in mending motion picture films; its general object is to provide a device whereby the film may be scraped at the ends to be jointed and conveniently prepared for receiving an adhesive material for the joinder of the ends, and means to dispose the film ends overlapped for pasting the same and insuring the correct register of the side openings in the respective ends.

HAIR NET.—C. R. PIEPER, c/o Iron Products Corp., 516 S. Second St., La Crosse, Wis. An object of this invention is to provide a process of manufacturing a spherical-shaped hair net by means of a plastic material, such as cellulose, which is passed through a molding device having a flat or curved surface. A further object is to provide a hair net which may be made of a cellulose material and colored to match various shades of hair. The device is free from any unsanitary conditions.

ROAD CONSTRUCTION.—J. B. WATTS, c/o Watts Construction Co., Concordia, Kan. The invention has for its object to provide a construction wherein there is provided means for permitting the top of the roadway to respond to temperature changes in expansion and contraction, and to permit the surface to be repaired or renewed without affecting the foundation or base of the roadway. (See Fig. 6.)

COMBINED STOP AND HANDLE FOR BORE-CLEANING RODS.—E. H. WILLIAMS, Florin Rd., Florin, Cal. The invention has particular reference to a cleaning rod for gun barrel bores. The principal object is to provide a simple member for longitudinally adjustable association with a cleaning rod to constitute a stop for engagement with one end of the barrel to limit the movement of the cleaning rod and prevent the entire projection of the end of the rod from the barrel. (See Fig. 7.)

BRIDGE CONSTRUCTION. — S. A. ROAKE, c/o Southern Pacific Railway Co., 165 Broadway, New York, N. Y. The primary object of this invention is the provision of a movable bridge, and more particularly a bascule bridge, which may be manufactured at a main plant and subsequently shipped to the point at which it is to be erected, the parts being so arranged and constructed as to eliminate any necessity of a supplemental assemblage plant, at the point of ultimate assemblage. (See Fig. 8.)

SELF-CLOSING GATE.—G. H. KNUTSON, R. F. D. No. 6, Pelican Rapids, Minn. An important object of this invention is to provide an automatic gate whereby the same is elevated by the weight of a vehicle when on either of a pair of runways at opposite sides of the gate. A further object is to provide means whereby the gate may be lowered when the vehicle has passed beneath the same. (See Fig. 9.)

DOUBLE BOILER.—J. R. SMITH, 920 Waverly St., Palo Alto, Cal. The invention has for its object the provision of a boiler so constructed that the maximum amount of surface of the inner container is subjected to the direct action of and contact with the boiling water. Another object resides in the provision of means whereby in the ebullition of the water, due to the steam bubbles, splashing the water out of the boiler is effectively prevented. (See Fig. 10.)

HIGHWAY SIGNAL.—W. V. BERGEN and A. C. SHUTE, c/o Niterday Signal Co.,

Hillsboro, Ore. Among the objects of the invention is to provide a device adapted to be permanently arranged along highways for indicating danger or need for caution, wherein a visual signal is provided capable of being seen either by daylight or at night, and having means for illuminating the same through the reflection of projected rays of the headlight of an approaching automobile, to render the same visible at night.

Hardware and Tools

WELDING TORCH.—W. J. FRANK, 2304 W. Fayette St., Baltimore, Md. One of the objects of the invention is to provide a welding torch of simple and light construction which will permit the use of a plurality of tips selectively, whereby the torch can be readily adapted by tip selection for use in welding operations ordinarily requiring the employment of a welding torch designed for either heavy or light work, according to the particular service requirements.

GAGE.—E. A. FRANCIS, Marshalltown, Iowa. This invention relates to a gage for measuring cylindrical bores and comprises a plurality of blades having rounded ends to conform to the rounded walls of various bores to be measured and having indications relating to the diameter of each bore, a common pivot upon which all the blades are mounted, and a cage in which the blades may be housed.

VALVE GAGE PULLER.—J. L. CUNNINGHAM and M. D. WHALEN, c/o W. L. Baker, Atty., Cresco, Iowa. The object of the invention is to provide a device of the above character by which the valve gage of the type employed for overhead valves in internal combustion engines may be lifted or pulled in an expeditious manner, and without injury. It is also an object that the device be simple in construction and inexpensive to manufacture.

HINGE.—F. W. MUHLENBRUCH, 20 Church St., Bergenfield, N. J. The invention pertains more particularly to hinges especially adapted for use on freight car doors. The primary objects are to so construct a hinge that in instances where it is especially difficult to open the car door the hinges may be removed without mutilation of the door or car, and may be easily replaced.

GARDEN TOOL.—W. J. KESSEL, 59 Garret St., Paterson, N. J. An object of this invention is to provide a tool which is primarily intended for weeding, and which can be used either for pulling, cutting or digging out weeds. The tool is simple and practical in construction, strong and durable, light in weight, and comparatively inexpensive to manufacture.

COMBINATION RULE, SQUARE, AND LEVEL.—R. E. MCGOWAN and F. W. MCCORBY, Box 81, Chanute, Kans. The general object of this invention is to provide a sectional tool having means whereby the sections are adapted to be disposed in longitudinal alinement to constitute a rule or at right angles to each other to constitute a square, and one of the sections constituting a level.

WRENCH FOR AUTOMOBILE PARTS.—F. B. PARKER, Robinson, Kan. The general object of this invention is to embody in a unitary wrench device a means adapted to variously engage the parts to be turned such as the cap of a gasoline tank, the radiator tank and the oil petcock for testing as to the oil in the crank-case. (See Fig. 11.)

SAFETY BUTT HOOK.—V. D. WHITE, Cottage Grove, Ore. Among the objects of this invention is to construct a safety hook which is simple and strong and durable, and highly efficient for use in logging, mining and like operations, the device including no detachable elements, such as nuts and bolts, but which includes means carried by the body for closing or opening the space between the bill point and body proper of the hook. (See Fig. 12.)

Heating and Lighting

SUPER-REFLEX OIL, GAS, HEATER.—O. R. AIKMAN, Salem, Ill. The invention is more particularly directed to a stove adapted for cooking or heating or for a combination of both of these functions, and in which kerosene or gas is employed as a fuel. An object is to provide a fire box adapted to become incandescent under the action of a flame, with means for returning the heated gas at predetermined points within its circulation through the stove to the hottest portion in order to obtain the greatest efficiency.

SMOKELESS HEATER.—C. H. RUTHERFORD and C. TOWNSEND, Box 726, Jerome, Ariz. The principal object of the invention is to provide an orchard heater that will emit practically no smoke. The device comprises a fire box having a conical top with a central opening, a smoke chamber mounted thereabove to receive the smoke, means for dripping water into the chamber creating steam in the same to absorb the smoke, and a draft means for guiding the products of combustion outward.

GAS AND LIQUID-FUEL BURNER AND IN THE PROCESS OF BURNING GAS AND LIQUID FUEL.—C. F. CURREY and K. E. LYMAN, c/o F. L. Loveless, New England Bldg., Topeka, Kan. The invention relates to burners providing for the converting of liquid fuel supplied under pressure, into vapor or gas, for mixing the vapor with air, and for burning the mixture to supply heat for any purpose. The general objects are to produce a simple, compact, light and durable burner that is capable of producing a heat that is intense, and capable of fluctuating both slowly and quickly from the most extreme heat down to almost a mere pilot light.

ACETYLENE GAS GENERATOR.—R. W. MILLER, Means, Ky. The object of the invention is to provide a simple strong and durable apparatus by means of which gas may be continuously generated, uniform in quantity, pressure and quality. A further object is to provide means for the feed and control of carbide, and automatic means to regulate this feed as well as to clean the gas.

BURNER.—E. E. CORNWELL and J. H. MCCREADY, Okmulgee, Okla. This invention has for its object to provide a gas burner tip which is adapted to effect thorough and intimate commingling of a hydro-carbon fuel and air admitted thereto at one end and passing therethrough to the other end of the tip. The tip is strong and durable, and capable of withstanding an intense heat.

FIREPLACE CONSTRUCTION.—L. B. WILLIAMS, 107 Agnes St., Hattiesburg, Mississippi. More particularly the invention relates to open fireplaces such as are installed in dwellings. An object is to provide means for regulating the draft and to permit the use of fuels of various descriptions, and means operable at will to convert the device from a closed to an open fireplace or vice versa. (See Fig. 13.)

FUEL SAVER.—A. BURDICK, 23 Dartmouth St., Pittsfield, Mass. The invention relates to auxiliary draft attachments for furnaces; the object is to provide a simple structure that may be applied to the furnace door to admit a supplemental supply of air above the fire for the purpose of securing more complete combustion of the gases rising from the fire. (See Fig. 14.)

Machines and Mechanical Devices

PHOTO ENLARGING MACHINE.—R. D. GRAY, Midland Park, N. J. Among the objects of the invention is to provide an enlarging machine which will enable the operator seated in front of the machine to conveniently reach the various parts and to quickly position the printing paper on the printing frame, and locate the latter in proper relation to an optical projector, permitting the operator to make a number of enlargements in a comparatively short time.

EXPRESSION DEVICE FOR PLAYER PIANOS.—O. E. WALL, Box 3048, Honolulu, Territory of Hawaii. This invention has for its object the provision of a tone control arrangement in which there will be minimum loss of vacuum both in the several adjusted portions as well as during the movement of parts from one position to another. A further object is the provision of an expression device in which there is an automatically controlled movement of the parts bringing about either slowly or speedily increasing volume as desired.

PNEUMATIC CONTROL DEVICE FOR PLAYER PIANOS.—O. E. WALL, Box 3048, Honolulu, Territory of Hawaii. The invention relates more particularly to the various mechanical or pneumatic features of pianos. The invention aims to overcome the necessity of either slots or closely spaced apertures, both of which materially weaken a note sheet, and a further object is to do away with this disadvantage by an arrangement which will be simple and inexpensive. A still further object is the provision of an arrangement in which by the simple addition of a single tracker board opening various pneumatic control devices may be actuated.

MOWING MACHINE ATTACHMENT.—E. E. KRANZ, Kirley, S. D. The invention particularly relates to an attachment commonly known as a dropper. An object is to provide a means of controlling the delivery of hay from the dropper and a means which may be readily operated by the driver of the mower. A still further object is to provide a dropping mechanism which is strong and durable in use and suitable for various forms of mowing machines.

WELL DRILLING ATTACHMENT.—H. R. ROWLAND, c/o V. D. Moody, 90 West St., New York, N. Y. The general object of the invention is the provision of a durable and simple device which will operate to grip the casing and to retain it in any desired position. A further object is the provision of means for centrally spacing the casing inside the lining, and means for closing the well in case a gusher is discovered.

CALCULATING MACHINE.—W. H. BERWICK, 732 Westcott St., Syracuse, N. Y. Among the objects of the invention is to provide a machine upon which a number of different amounts may be recorded and a result obtained which will give the minimum number of bills and coins necessary to make up all of the amount. A further object is to provide a machine in which each unit of currency is calculated separately and mechanically, the necessity of mental calculation being entirely eliminated.

VENDING MACHINE.—F. F. MOLLOY, 243 Ontario St., Montreal, Canada. This invention has for its object the provision of a simply operated machine for the vending of any articles, in which the operation depends upon the insertion of coins and the manipulation of a handle, which cannot be effectively operated unless the proper number of coins have been inserted. Another object is to provide means whereby only a predetermined number of articles can be ejected upon the insertion of a defined amount of money.

PROCESS OF AND APPARATUS FOR MANUFACTURING ICE.—R. F. LINDSAY, c/o Mrs. M. E. Brown, 3106 Lee St., Dallas, Texas. The purpose of the invention is the provision of a process and apparatus by means of which pure crystal ice can be made from any water, irrespective of the impurities contained in the water. It is also a purpose to provide an apparatus which eliminates the use of brine and its attendant disadvantages, and which permits of the harvesting of the ice in the daytime and in blocks of different sizes.

BRUSH FOR TALKING MACHINES.—J. F. BORST and W. BORST, 1117 Cypress Ave., Ridgewood, Brooklyn, N. Y. The primary object of the invention is to provide a brush capable of attachment to the sound box of a talking machine in such manner that the brush will be resiliently carried in the path of the stylus, and remove foreign material therefrom. It is a further object to construct a frame for supporting the brush of material which has low qualities for sound transmission.

BAILER.—A. BOYNTON, 1800 San Pedro Ave., San Antonio, Texas. The invention relates to bailers especially adapted for removing such material as mud and slush from oil or water wells. An important object is to provide a bailer having a plurality of material discharge openings in the sides, with greater area than the cross sectional area, so that the material may be readily and conveniently discharged. A further object is to provide a bailer having means whereby heavy and stiff mud may be thrust out through one side of the bailer by means of a tool, inserted from the opposite side.

ATTACHMENT FOR LATHES.—D. P. FONTANA, 314 W. 19th St., New York, N. Y. An object of the invention is to provide an attachment which constitutes a positive means for preventing relative movement between the tool rest support and the work to prevent injury to the operator or spoiling of the work resulting from slippage of the tool rest support. More specifically, the invention aims to provide a connection between the tool rest support and either the head or tail stock of the lathe, for preventing relative movement between the tool rest and the work.

DENTAL CASTING MACHINE.—S. L. JEFFERIES, Gaffney, S. C. This invention has been granted two patents of a similar

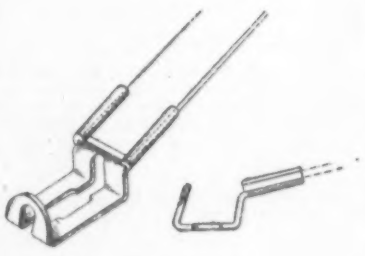


Fig. 11. Automobile wrench that is different, the design of F. B. Parker

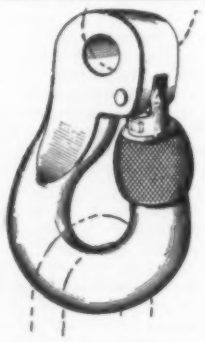


Fig. 12. V. D. White's safety butt hook without detachable parts

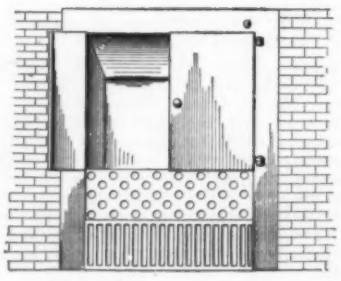


Fig. 13. Novel open fireplace construction devised by L. B. Williams

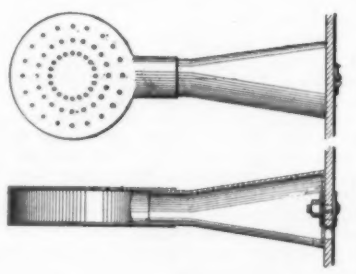


Fig. 14. Auxiliary draft attachment for saving furnace fuel, invented by A. Burdick

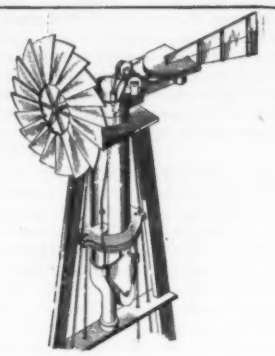


Fig. 15. Windmill security is attained by J. P. Berger's attachment

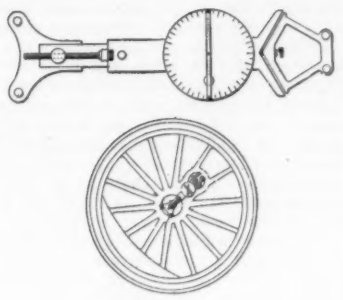


Fig. 16. Wheel quartering gage, invented by R. R. Royal and D. H. Brown

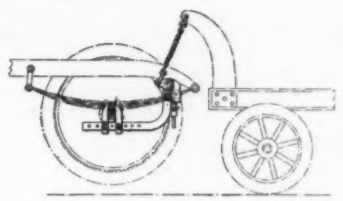


Fig. 17. Towing the crippled automobile with H. M. Holt's invention

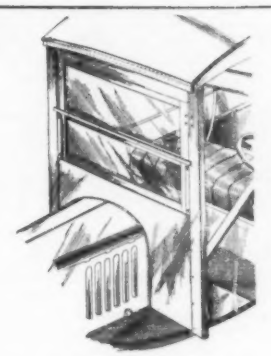


Fig. 18. E. B. Bourlier's metal front for automotive bodies

nature, their object being to provide a dental casting machine by means of which the fusing of gold, porcelain, or like material, from which teeth are formed, and the casting of a tooth, may be accomplished in one operation in a highly expeditious manner. It is a further object that the machine be extremely simple in construction and inexpensive to manufacture.

SPINNING FRAME AND CAM.—J. P. McCAVITT, 917 Columbia Ave., Millville, N. J. This invention relates particularly to a cam and associated spinning frame, the construction being such that the spindles on the frame are adapted to receive an extra large supply of yarn. An object is to provide a cam interposed in the driving mechanism of the spinning frame whereby a slow and fast motion may be secured to permit an extra supply of yarn to be wound at a desired point.

OIL PRESS.—R. S. MATHESON, Manila, Philippine Islands. The invention has for its object to provide a press of the character mentioned by means of which the material from which the oil is pressed may be fed continuously between moving elements which compress the same to express the oil and which finally deliver the pomace at the opposite end of the machine.

APPARATUS FOR CLEARING INTERMEDIATE FEED CHUTES.—J. MEINECKE, c/o Calton Mill Co., Paia Maui, Territory of Hawaii. An object of the invention is to provide an intermediate chute to be disposed between adjacent mills including two inclined portions, one of which is hinged at the summit so that it may be tilted for the purpose of clearing the chute. The invention is particularly adapted for use in connection with cane sugar mills.

PIN.—J. EVANS, 137 No. 8th St., Salt Lake City, Utah. Among the objects of the invention is to provide a sorting device or pin for materials which may be utilized to advantage in connection with a sorting machine. A further object is to provide a pin, the parts of which are normally locked, so that any material associated with these parts will not be accidentally detached, but in which these parts will be unlocked in a semi-automatic manner upon the pin reaching its final position.

GUARD FOR BUFFING WHEELS.—G. MORGAN, 17 River St., Port Dickinson, N. Y. An object of the invention is to provide a guard for the buffing wheels of shoe machinery and the like, which can be conveniently attached to the machine and which will function to prevent scarring of uppers, over-counters and back stays of shoes while buffing the heels. A further object is to provide a guard capable of adjustment, and allowing the sandpaper to be replaced.

WASHING MACHINE.—A. F. HECHT, c/o General Delivery, Worth, Ill. Among the objects of the invention is to provide a washing machine which is constructed in such manner that in its operation the water is moved so as to always keep the clothes agitated and to prevent the rolling up of the clothes into wads, the clothes being moved to the sides of the machine then carried upwardly and back to the center.

MACHINE FOR CUTTING KEYWAYS.—J. ALLEMAN, 201 W. Duncannon St., Philadelphia, Pa. The primary object of this invention is to provide a machine tool adapted to be attached to a lathe bed whereby such operations as key-way cutting and shaping may be carried out by hand. A further object is to provide a combination tool by means of which certain parts may be replaced by other parts to provide a power-operated grinding tool.

ICE MAKING APPARATUS.—O. J. MORRIS, 82 Ridge Ave., Atlanta, Ga. The invention relates to an ice making apparatus of the stationary ice mold type in which the cakes of ice must be lifted directly from the molds. An object is to provide means for filling the ice molds by overflowing connections from one mold to another, and purifying the water, during the process of freezing, by overflowing the impurities.

ATTACHMENT FOR WINDING MACHINE.—M. LANDI, 49 Bond St., Paterson, N. J. The purpose of this invention is to provide an attachment for a silk winding machine which may be applied in numbers, one for each of the bobbins employed upon the machine and which is adapted to limit the amount of silk or other thread wound upon the bobbin, that is to say when the bobbin becomes fully wound the attachment will bring the bobbin to a stop and thus discontinue the winding, but will not interfere with the normal operation of the machine.

PLATING MACHINE.—W. DIETZEL, Merrick, L. I., N. Y. Among the objects is the provision of a construction which is especially adapted for plating small articles and capable of acting as a pickling machine. Another object is to provide a construction utilizing a spiral trough for tumbling articles during the plating, so that a continuous operation may be performed and the articles continuously fed in at one end and discharged at the other end completely plated.

ATTACHMENT FOR HEMMERS.—G. T. AXT, 600 Passaic Ave., Nutley, N. J. An object of the invention is to provide a simple and readily applicable attachment for hemmers whereby the operator can quickly and easily advance the material being hemmed to the hem securing mechanism and without any danger of injuring the fingers. The device may be readily applied to and detached from any type of hemming mechanism.

WINDMILL ATTACHMENT.—J. P. BERGER, Box 474, Uvalde, Texas. An object of the invention is to provide an attachment embodying means for preventing the cut-off chain or cable of a windmill from disengaging the guide pulleys without interfering in any way with the functioning of the cut-off chain and pulleys in an ordinary manner. The device is simple and is adapted to be applied to a windmill without change to the ordinary construction. (See Fig. 15.)

Medical Devices

SURGICAL APPLIANCE.—S. A. BATES, 3101 Miami St., St. Louis, Mo. The invention relates to surgical appliances and more particularly to a device for use in connection with surgical operations on the intestines and where such operations necessitate the severing of the intestine. An object is the provision of a thimble for maintaining the severed ends of an intestine, distended after an operation has been performed.

Prime Movers and Their Accessories

AIR-FEED DEVICES—E. M. PERFECT, 7007 Cedar Ave., Cleveland, Ohio. This invention relates to an attachment for internal combustion engines which insures a feed of air into the intake manifold in the engine in proportion to the feed of fuel from the carburetor, an object being to provide a device which results in an economy of fuel consumption so that increased mileage may be had from a given quantity of gas, to insure a more perfect combustion and a complete burning of the mixture, and to reduce the formation of carbon to a minimum.

INTERNAL-COMBUSTION ENGINE.—A. F. VAN AMSTEL, Amersfoort, Netherlands. The invention relates to internal-combustion engines of the type wherein the cylinder is in constantly open communication with an auxiliary chamber through a permanently restricted passage. The device consists in that a spreader is disposed partly before and partly in the cylinder end of the restricted passage, so that the fuel jet which is injected through this passage, into the cylinder, on meeting the spreader, is broken up into spray and partly evaporated.

GAS PRODUCER.—D. J. SMITH, 40 Woodberry Grove, Finsbury Park, London, N. 4, Eng. The object of this invention is to provide means for performing mechanically some or all of the functions of the producer and especially to provide alternative means in producers, for mechanically operating the producer in order that it may be operated independently of the internal combustion engine or the like to which the producer supplies gas.

SPARK PLUG.—J. ANDERSON, 1627 Preble St., Charleston, Wash. The invention has for an object to provide a leak-proof spark plug which will have an all metal outer shell or surface and which can be readily assembled and taken apart as occasion may require. The space between the core and the body is rendered gas tight by gaskets located at the shoulders of the core and also at the upper end, and these parts are clamped together by nuts.

ENGINE.—A. R. CARTER, Gulfport, Mississippi. The invention particularly relates to multiple piston steam engines. An object is to provide an engine which is adapted to be started by the pressure of steam in any phase of its operation, which prevents condensation in the working chambers, which possesses flexibility and compactness and other features especially adapting it to fulfill the requirements of an automobile steam engine.

Railways and Their Accessories

COUPLING FOR RAILWAY AND LIKE VEHICLES.—F. A. MACKINNON and J. HAMPSON, c/o Brown & Co., 9 Warwick Court, Holborn, London, W. C., England. The invention relates to couplings of the type in which on two vehicles being brought together, the shackle of one is automatically guided into engagements with a hook on the other. The general principle is to provide a draw hook with a pivoted member having a lower hook adapted to take over a shackle of an adjacent vehicle.

WHEEL QUARTERING GAGE.—R. R. ROYAL and D. H. BROWN, McComb, Miss. This invention relates to gages for quartering the wrist pins of locomotive drive wheels and more particularly relates to attachments for the gages whereby to effectively gage the position of the wheels with the wrist-pins accurately quartered or at right angles before premanently driving the wheels onto the axle. (See Fig. 16.)

CAR REPLACING DEVICE.—W. A. HUBBARD, 2728 Pacific Ave., Hoquiam, Wash. An object of the invention is to provide a simple and efficient car replacing unit which embodies means whereby it may be releasably and firmly held clamped against a track rail and disconnected from the rail at will for use at another point. The device is adapted to be connected in such manner that a stress thereon will tend to prevent displacement or movement of the replacing unit relatively to the rail.

SWITCH LOCK.—J. D. MOORE, Box 181, Jacksonville, Fla. The object of the invention is to permit of the release of the lock by virtue of the initial movement of the switch-throwing lever, and at the same time provide such connections that the switch stand and the switch-throwing parts will be so divorced from the switch that the latter will be unaffected by breakage of the switch stand and its support either in whole or in part.

Pertaining to Vehicles

ATTACHMENT FOR WAGON DUMPS.—E. D. MCCULLOUGH and A. W. BUTCHER, c/o Gravity Dumps Mfg. Co., Abilene, Kan. An object is to provide an attachment whereby trucks as well as wagons may be readily dumped. A further object is to provide a device of the type described which may be easily attached to a wagon dump of ordinary construction, or may be instantly released from the wagon dump.

RADIATOR REPAIR COMPOSITION.—F. PETMECKY, 505 Congress St., Austin, Texas. This invention relates to a composition for introduction within automobile radiators and other metal parts of similar nature for the purpose of closing small leaks, especially those difficult to reach by solder, the object being the provision of a material which will adhere firmly and closely to metal, and will not endanger clogging of the water channels.

CONTROLLING MEANS FOR DUMPING BODIES.—J. H. HUTCHINSON, 259 Bridge St., Port Melbourne, Victoria, Australia. Among the objects of the invention is to provide a device employed in connection with load-carrying bodies which will enable the same to be brought to dumping position quickly and easily; and will enable the same to be returned to normal position and locked against movement. The device may be applied to any conventional type of vehicle.

OILING SLEEVE.—E. C. FURNAS, c/o Shirr Ruffle Co., Lima, Ohio. Among the objects of the invention is to provide an oiling sleeve for semi-elliptical and elliptical springs of automobiles and other vehicles, the oiling sleeve being so formed that it readily adapts itself to leaf springs with retaining clips thereon, a protecting member and an oiling pad being arranged to receive oil from time to time without the removal of the sleeve.

ILLUMINATED LICENSE TAG AND SIGNAL FOR AUTOMOBILES.—W. R. GARNER, 400 St. Paul Place, Box 783, Baltimore, Md. The foremost object of this invention is to provide a combined automobile license tag and rear end signal, the numerals and letters of the former being cut out so that a single lamp on the inside may be made to shine through both the openings and the signal lens, the license tag and color screen being replaceable upon expiration of the period for which the tag is issued.

AUTOMOBILE TOWING FRAME.—H. M. HOLT, 531 W. 57th St., New York, N. Y. Among the objects of the invention is the provision of a frame which can be quickly applied to an automobile, to engage beneath the springs and the axle, and merely by reason of the forces exerted to lift the end, or to tow the vehicle, the device being firmly held against the parts with which it is contacting. (See Fig. 17.)

METAL FRONT FOR AUTOMOBILES AND TRUCK BODIES.—E. B. BOURLIER, 912 So. 8th St., Louisville, Ky. The general object of the invention in constructing a metal front, is to provide one so formed that it will remain a solid unit without danger of distortion, and warping, as is often the case with wooden fronts, the metal front eliminating all danger of rattling or other noises. (See Fig. 18.)

Of General Interest

MANICURE IMPLEMENT.—J. O. LANDIS, 40 So. Church St., Waynesboro, Pa. Among the objects of this invention is to provide a safe and convenient combined finger nail cutting and cleaning implement, which may be carried in the pocket without injury to itself, the person of the carrier, or other articles that may be contained within the pocket, purse or other receptacle, the blade being so mounted that it may be readily moved to either extended or retired position.

CASKET SUPPORT.—J. E. JONES, Lockhart, Texas. The invention relates to supports upon which a casket may rest when placed over a grave previous to the lowering thereof. The object is to provide supports which are extensible and adapted for any width of grave. It is also an object that the supports be so shaped that they will not have any tendency to roll when supporting a casket, and also that they be adapted to close into a compact unit for transportation.

CLOTHESPIN.—J. T. PILKINGTON, Vernon, B. C., Canada. The invention aims to provide an extremely simple and inexpensive device of this character, which is especially designed for use in connection with pulley lines, whereby the same will function to pass around the grooved pulley upon which the line is mounted. The clothespin being constructed of metal, is practically indestructible.

ROLL FILM FOR CAMERAS.—W. D. HANSEN, 2127 Milwaukee Ave., Chicago, Ill. The invention relates to roll film for a camera of that type having a focusing opening in its rear end, and a purpose of the invention is the provision of a roll film so constructed as to permit of the successive presentation of portions of the film to the focusing opening and to allow of the focusing of the camera lens through such openings prior to each exposure.

EGG BEATER.—P. J. DIEHL, 124 Standard Ave., Butler, Pa. The invention relates to an egg beater so called, and is particularly intended for embodiment in the beaters of cake mixing machines for mixing batter, icing, etc. The general object is to provide means for attaching the beater arms to the head in such a manner that all danger of breaking at this juncture is practically eliminated.

BROOM CLAMP.—J. T. JACOBSON, 631 46th St., Brooklyn, N. Y. Among the objects of the invention is the provision of a simple, efficient and durable device which can be readily applied to a broom, and as easily removed therefrom, to adjustably clamp the fibers or straws so that the broom fibers will be held more or less firmly, as desired. The clamp may be adjusted and is provided with latching means.

SELF-CLEANING LAVATORY.—W. T. GUTH, 149 Van Dyke St., Brooklyn, N. Y. This invention has for an object to provide a construction of bowl and flushing means whereby the bowl may be readily cleaned and flushed at the same time. A further object is to provide a self-cleaning lavatory whereby upon the turning of a single spigot water is discharged in several directions and automatically converted into a sheet as it moves into the bowl proper.

CLIP FOR PENS, PENCILS AND THE LIKE.—G. W. GILMAN, JR., c/o Parker Pen Co., Janesville, Wis. It is the primary object of this invention to increase the strength of a clasp of the above nature and thereby prolong its life. A further object is to so construct the clasp that the rigidity thereof is likewise increased, thus causing the clasp to take a firmer grip to retain the article by which it is carried in position.

SHAMPOO CUP.—LILLIAN M. LEA, Bellop Ave., Tottenville, S. I., N. Y. An object is to provide a simple and effective device for holding a supply of shampoo fluid and for affording means to facilitate the application and distribution of the fluid on and over the head to expedite the shampooing operation. A further object contemplates a device which affords a convenient means for mixing the constituent elements of the shampoo agent prior to its application.

LADDER SCAFFOLD BRACKET.—F. T. PETERS, c/o F. T. Peters & Sons, 127 Eastdale Blvd., Springfield, Ill. Among the objects of the invention is to provide a device of the character described which may be quickly and easily attached to the ordinary type of ladder, which may be adjusted to support a load in a horizontal plane, notwithstanding the fact that the ladder supporting the bracket may be at one of various angles from the vertical, the device being held securely by the load supported thereby.

PROCESS OF PRODUCING VERMICULATED WORK.—J. H. DELANEY, 407 S. Hope St., Los Angeles, Cal. The invention relates primarily to building materials such as artificial stone work. The object is to produce vermiculated work upon the surface of plastery materials, which consists in embedding in the surface of the material before the same has set particles of material capable of generating gas in the presence of moisture to thereby produce voids in the surface of the material for the purpose of ornamenting the same, and giving the appearance of an antique structure.

BOOKMARK.—R. MALLINA, 264 Riverside Drive, New York, N. Y. The invention has particular reference to means not only to provide a mark to indicate where the reader stopped reading, but which also holds the leaves of the book in position while the book is being read, while in no way interfering with the turning over of the leaves of the book. The device is constructed in such a way that it can be slipped on and removed from the book with ease.

PAPER DISPENSER.—A. F. LESLER, 74 Dey St., New York, N. Y. Among the objects of the invention is to provide a dispenser for protecting toilet paper, and the provision of a simple holder adapted to dispense the paper one sheet at a time. The arrangement is such that the supporting members will act as cutters as the paper is removed. A further object is to provide means for preventing the paper from becoming tangled as the sheets are successively removed.

GOLD SOLDER.—W. and H. W. SHEFF, 336 Canal St., Brooklyn, N. Y. An object of the invention is to provide a simple and easily manipulated solder for use in the manufacture of jewelry made of so-called "white gold." A further object resides in the provision of a solder that has the proper color to conform to the color of the jewelry with which it is being used, and yet which is easily manipulated and will at all times retain its orignal color.

MUSIC LEAF BINDER.—W. C. TRAHER, 863 Maitland St., London, Ont., Canada. The purpose of the invention is to provide a device of this character which will give the binder a rigid and substantial back adjusted for expansion in order to accommodate a varying number of music leaves, and which is not likely to sag or to lose its shape when holding a relatively large quantity of leaves. With this device it is easy to remove any sheet of music without disturbing the others.

TOP.—E. E. BARTRAM, 811 Hollingsworth, Los Angeles, Cal. An important object of this invention is to provide an educational device in the nature of a pair of tops having a plurality of numbered faces, the numbered face of one top coating with the numbered face of the other. A further object is to provide an educational and amusement device which is simple in use and inexpensive to manufacture.

BOOKMARKER.—J. C. WISE, 623 20th St., Oakland, Cal. Among the objects of the invention is to provide a combination envelope and bookmarker, or rather an envelope which when discarded may be converted into a bookmarker, so that the envelope may be made to serve two purposes, and even a third, when it is considered that it may also be used for advertising features.

SMOKING PIPE.—A. G. BROMSTER, Amidon, N. D. The invention relates to pipes for smoking tobacco, and has for its object to provide a pipe which has means for causing the smoke to pass a circuitous path before reaching the mouth of the smoker, thereby cooling the smoke and permitting a deposit of nicotine, but having means also for preventing the saliva from entering the flues in which the smoke is compelled to pass.

MAIL BOX.—J. A. NICHOLS, Box 304, Egan, S. D. Briefly stated an object of the invention is to provide a mail box which can be opened by the carrier without removing his gloves in winter, or without other inconvenience. A further object is to provide a rural mail box having novel means whereby the letter carrier may quickly observe if there is any mail in the box, thereby saving time, it is also an object to provide a strictly weather proof construction.

PROCESS FOR RECLAIMING USED OIL.—J. R. MILLER, 3960 Brandon Rd., N. S. Pittsburgh, Pa. The invention relates to the reclaiming of oil such as is used in the crank cases of internal combustion engines. An object is to so treat the oil that the dirt will be coagulated, the volatile hydrocarbon with which the oil is contaminated will be driven off, and without causing any substantial change in the composition of the reclaimed oil, thereby producing to all intents and purposes an equivalent to the unused oil.

DISPLAY STAND.—G. J. HELENEK, 421 Hancock St., Long Island City, N. Y. Among the objects of the invention is to provide a construction which will display articles while holding them in a compact arrangement. Another object is to provide a stand for displaying tubular articles or rolls without using too much floor space, whereby the rolls may be readily removed and reinserted without injury and in a minimum amount of time.

Hardware and Tools

FISHING TOOL.—C. H. BROWN, c/o Brown Welding and Machine Co., Breckenridge, Texas. An important object of the invention is to provide a fishing tool having a plurality of spring arms which diverge toward their forward ends and are provided with means for gripping the valve seat of the valve cage and thereby removing the valve cage on the rearward movement of the tool. A further object is to provide a tool in the shape of a spear which will readily enter the valve cage when the tool is lowered for removing the broken cages from oil wells.

KNIFE.—W. CLAWSON, 684 Falsom St., San Francisco, Cal. The invention has particular reference to a knife used for slicing bread or similar objects, the principal idea being to provide guide means in combination with the knife allowing a slice or a plurality of slices to be cut at a uniform thickness. It is further proposed to construct the guide member in such a way as to allow the cut slices to pass between the guide member and the blade and to fall away from the latter during the cutting.

PIVOT LATHE FOR WATCHMAKERS.—D. K. ROBINSON, 3410 Garrison Blvd., Baltimore, Md. An object of this invention is to provide a lathe for facilitating the inspection, straightening, adjusting, refining and polishing of the pivot joints of horological balance wheels and train gears. A further object is to provide a device which has one pivot supporting member movable on the axial plane of the pivot, and the other pivot supporting member movable in a plane transverse to the axial plane of the pivot.

LOCK-SCREW.—A. FLENTJEN, Canton of Geneva, Switzerland. The invention relates to lock-nuts of the type in which a longitudinally split locking-nut fits into a conical recess of the ordinary nut. This lock-screw comprises a lock-nut having a conical outer portion adapted to be introduced into a conical recess of a main nut, the conicity of the lock-nut being different from that of the conical recess of the main nut and the cone of the lock-nut and of the main nut diverging toward the respective outer end of the nuts.

DUMB-WAITER LOCK.—J. E. PHILLIPS, 260 Convent Ave., New York, N. Y. The invention particularly relates to locks adapted for the doors of dumb-waiters or doors operating in a similar manner, and has for its object to provide a construction which may be easily operated from the inside, but cannot be operated or forced from the outside. The lock is extremely simple and is constructed to take the place of an ordinary bolt and lock at the same time.

Machines and Mechanical Devices

ROAD BUILDING AND DITCH CLEANING MACHINE.—G. A. STEVENS, Ringwood, Ill. The invention has for its object to provide an apparatus which when drawn over a road or ditch, will give the proper pitch or crown to the road or angle to the ditch, and which is capable of a wide range of adjustment in accordance with the work to be done.

WIND TURBINE.—E. H. MANNING, Elkhart, Ind. An object is to provide a wind power device which includes a rotor adapted to be acted upon with full efficiency at all times, irrespective of the direction of the wind, and which requires no adjustment or shifting of parts to compensate for the changes in the direction or velocity of the wind impinging there against, and retaining the air currents within the limits of the device until the effective force has been spent.

AUTOMATIC HYDRAULIC APPARATUS.—P. SAMAIN, Cusy, Haute-Savoie, France. An object of the invention is to provide a device by means of which the pressure exerted by a liquid in a conduit may be automatically controlled. A further object is to provide a device which will operate to automatically close the conduit in case the latter should break, when the rush of fluid will cause the displacement of a pendulum which operates to close the conduit valve.

YARN TWISTING DEVICE.—C. E. MCLIN, Box 617, Rome, Ga. It is an object of the invention to eliminate all but one roller and to inject between the roller and the twisting spindle a cylindrical or semi-cylindrical rod which is corrugated, fluted, or bent at necessary intervals to receive the thread and around which the thread is drawn, or the rod may be supplied with a plurality of disks, whereby the disks when engaged by the thread will readily adjust themselves to prevent the strands of yarn drawn from the spools from piling up one upon the other.

REVOLVING CARD DEVICE.—C. E. SHAW, Box 18, Gig Harbor, Wash. The general object of this invention is the provision of a device having means whereby a number of cards may be exposed in rapid sequence so that the matter on the several cards may be viewed. A further aim is to provide a flexible strip whereby the cards are supported so that the continued exposure of the same will not weaken or crack the cards.

WATER POWER MOTOR.—M. I. TUTTLE and L. L. HILL, Belton, Mont. The particular object of the invention is to provide a water power motor wherein a plurality of gravity operated balancing tanks are utilized to transmit motion to a power shaft. A further object being to provide a mechanism for automatically controlling the flow of water into the tanks and discharging the water from the tanks, so arranged that the weight of a descending filled tank operates to restore an empty tank to a position where it may be refilled.

WORKING BARREL.—W. W. WARNER, Box 157, Nowata, Okla. Briefly stated, an important object of the invention is to provide a working barrel for wells, having means whereby sand or other granular material suspended in the liquid is prevented from settling on the pumping cups, thereby greatly prolonging the period of usefulness of the cups and preventing the loss of oil or water incident to the frequent replacing of the cups.

ATTACHMENT FOR SHOE STITCHING MACHINE.—T. F. MCREYNOLDS, 110 E. Fifth St., Walsenburg, Colo. The invention relates to a shoe stitching machine attachment enabling the ready application of a welt strip. One of the foremost objects is to provide a guide operating in conjunction with a well known type of shoe stitching machine for the purpose of applying a welt strip to new or old shoes, as the shoe is manipulated in the stitching operation.

PULLING DEVICE.—E. W. BRAUTIGAM, 1101 E. Lakeshore Drive, Coeur d'Alene, Idaho. The object of the invention is to provide a lever chain pulling device wherein a single strand of chain is used and is controlled in such a manner as to prevent tangling, and at the same time is driven from the lever in such manner as to exert a powerful pull. Another object is to provide a device which is durable, automatically reversible and may be actuated by the operator to slacken.

SORTING OR SIZING APPARATUS.—LE ROY D. SPENCER, Box 76, Entiat, Wash. Among the objects is to provide an apparatus by which apples or the like may be sorted or graded into different sizes in a highly efficient and expeditious manner, and whereby in sorting the apples or the like the same will not be bruised. The apparatus is simple in construction and inexpensive to manufacture.

PULLER FOR SLEEVE BEARINGS.—C. W. TRACY, c/o Tracy Pump & Machine Co., Visalia, Cal. This device is particularly useful in pulling "Timken" bearings. A bolt has a cylindrical block to be entered in the sleeve to be pulled. Dogs on the block are expanded by a tapered nut on the bolt into engagement with the ring; when the device is engaged with a sleeve bearing the turning of the bolt causes the nut to travel on the stem and this slides the block with the dogs to carry the sleeve bearing out of the housing.

MASTER TEMPLATE FOR GASKETS.—A. SHARPE, 31 McKibben St., Brooklyn, N. Y. This invention relates to templates for measuring devices, and has for an object the provision of means whereby ready measure-

ment may be made of irregular formations, such as gasket patterns, etc. A further object resides in the provision of a combination of devices whereby the dimensions of irregular apertures in pipes or other passages may be measured and the variation from the required dimensions of gaskets to fit in said apertures may be readily determined.

WIND MOTOR.—W. R. TWIFORD, 1306 N. E. Second Ave., Miami, Fla. The invention relates to a windmill of the merry-go-round type, or type in which a series of blades is carried by a frame to revolve about the mast as an axis, the blades feathering to present in succession a broad surface to the wind at the wind side and to be presented more or less edgewise to the wind at the opposite side of the axis of rotation of the motor. An important object is to provide a controlling wheel in substitute for the usual vane for controlling the blades.

PULVERIZING APPARATUS.—J. AUBE, 63 Avenue des Champs Elysees, Paris, France. The invention has for its object an apparatus which effects an economy of power, and is arranged to be easily dismantled and inspected. This result is obtained by utilizing a turbine in such a way as to cause the air which has carried away the dust to return to the apparatus, after it has been freed therefrom, and by evacuating the pulverizing products through the upper part of the apparatus by means of a circulating trunk communicating with the interior through openings which are adjustable.

DENTAL ATTACHMENT.—J. J. STARK, 564 Senator St., Brooklyn, N. Y. The aim of the invention is to provide an attachment for dental lathes, and more particularly a power mixer for material for making dental casts, and comprising self-contained structure attachable to the horizontal spindle of a dental lathe, such structure including a receptacle for the mix, and a beater therein rotatable about a horizontal axis.

VALVE.—A. E. ROPE, Hillyer Hall, 102 Remsen St., Brooklyn, N. Y. Among the objects of the invention is to provide a valve having a turning movement and a longitudinal movement imparted by screw threaded engagement between the valve and the casing, whereby the valve is caused to tightly seat and form a water, air or steamtight juncture with its seat under any pressure. This valve can be manufactured at a reasonably low price.

OIL WELL EQUIPMENT.—A. T. HAGAMAN, Box 455, Oakland, Ky. An important object of the invention is to provide a pumping means for wells having a supplemental or reserve traveling valve which is normally located in the lower portion of the working barrel and which is brought into play in the active portion of the working barrel when the main traveling valve becomes worn and unsafe for efficient pumping.

DRILLING MACHINE MOUNTING.—M. SMITH, c/o L. E. Smith, Modesta, Cal. An object of the invention is to provide a mounting for a machine of this type which is capable of a very wide range of adjustment so that the maximum scope of operation may be provided for the drill without resetting the drill on the main support. Another object is to provide a mounting in which the drill may be rapidly adjusted at different levels, so that the horizontal range of the machine may be multiplied by adjusting its vertical position without moving the support.

Prime Movers and Their Accessories

LUBRICANT GUN.—G. A. PETTIT, L. & N. R. R. Co. Shops, New Orleans, La. The invention relates to devices for forcing a lubricant into suitable receptacles or cups. An object is to provide a device of the character described which is designed primarily for use in filling the rod cups on locomotive engines. The device is adapted to be operated conveniently to force a relatively hard lubricant therefrom into the oil cups.

VALVE ROCKER ARM.—R. E. HEDBERG, Grenfell, Saskatchewan, Canada. This invention relates to a rocker arm of the class commonly employed for operating the valves of internal combustion engines. An object is to provide a rocker arm so constructed that there is no danger of the valve being held off its seat allowing a leakage, and a rocker arm which will cause the valve operating parts to operate silently and in exact time with the rest of the engine, thus insuring a quieter and better running engine.

VALVE SPRING COMPRESSING MACHINE.—G. S. ROBERTS, Box 52, R. F. D. 6, Los Angeles, Cal. The invention particularly relates to that class of machine used in compressing the valve springs of internal-combustion engines for the purpose of assembling or disassembling the valves for grinding or repairing, etc. A further object is to provide an attachment for the machine in the form of a shim punch so that the same machine may be used either for compressing valve springs or punching shims.

LIQUID FUEL PURIFIER.—J. H. GANNON, Tucson, Ariz. The object of the invention is to provide a purifier for straining liquid fuel for use in internal combustion engines, to provide an arrangement of compartments and screens in such device, and to provide means for easily cleaning the device.

Railways and Their Accessories

AIR BRAKE VALVE.—F. E. HARRIS, c/o W. H. Hayes, First National Bank Bldg., Laramie, Wyo. The invention relates to air brake systems, its purpose is to provide a valve adapted to be interposed between the triple valve and brake cylinder for controlling the passage of air to and from the brake cylinder in accordance with the pressure of air in the train line.

ANGLE COCK.—E. P. CLAUSS, 26 Maple St., Lyons, N. Y. Among the objects is to provide an air brake system for trains wherein the angle cock cannot be closed or shut off until the brakes have been applied, the arrangement being such that the setting lever is placed from the angle cock at such a distance that an operator cannot touch the setting lever and the angle cock at the same time.

PROCESS AND MEANS FOR SWITCHING RAILROAD CARS.—F. W. EAGELSTON, 1409 W. Adams St., Chicago, Ill. An object of the invention is to provide a process which makes use of a simple and economical car propelling means, and may be readily installed in any switch yard for switching railroad cars. A further object is to provide means for quickly classifying cars, and reducing the number of locomotives necessary for the switching operation to a minimum. The process will not prevent the yard being used in the ordinary way.

SAFETY APPARATUS FOR RAILWAY ROLLING STOCK.—H. S. VOTAW, Chopaka, Wash. The object is to provide a safety apparatus which is organized with the trucks of the rolling stock and which serves as a derailing guard in that it prevents the cars or trucks from leaving the railway and also serves to apply the brakes when the car wheels leave the rails and thereby stopping the train. This apparatus will not interfere with the normal operation of the rolling stock.

RAILWAY CROSSING.—J. P. HOUK, Mountain Grove, Mo. The invention particularly relates to railway crossings of the type embodying means for automatically rendering the track rails continuous for the passage of car wheels across the crossing, thereby obviating the jars, shocks and wear which would be caused by the wheels when they cross a gap between intersecting rails. A further object is to provide a railway crossing which affords facilities for maintaining continuity of hard rails for trains traveling at right angles to each other.

SAFETY APPLIANCE FOR RAILWAY SWITCHES.—B. R. HOOKS, Amarillo, Texas. An object of the invention is to provide a device which is adapted primarily for guiding the wheels of a train past a defective switch and maintaining said train on its direct route of travel. A further object is the provision of a safety device for laterally shifting the wheels of a train from a defective switch point and which is also adapted to prevent injury to the switch points.

PANTOGRAPH.—R. B. SPIKES, 607 First National Bank Bldg., San Francisco, Calif. The invention relates to a device commonly known as a pantograph and used in connection with electric railroad cars for establishing a connection with a wire supported above the car. An important object is to provide control means for pantographs that will answer automatically to pressure, and will cause the contact member to rise and descend to meet any situation that may arise.

TRACK LEVEL.—C. M. LONG, 1261 N. Dearborn St., Chicago, Ill. An object of the invention is to provide a track level which is adapted to straddle a track, and which has means for indicating the height at which one rail is disposed above the other rail. A further object is to provide a device in which reading may be done from either side or from the top, and which has means for automatically disposing the device at right angles to the rails.

AUTOMATIC DRIFTING DEVICE FOR LOCOMOTIVES.—B. L. HANSON, 5331 Beach St., Chicago, Ill. Among the objects of the invention is to provide a drifting device which will be automatically operated when the throttle of the locomotive has been closed while the engine is in motion, thereby permitting a flow of dry steam through the valve chamber and cylinder, thus preventing cinders, soot and the like from being disposed in the valve chamber and providing a cushion of steam therein; the device can be readily applied to locomotives of ordinary construction.

RAILWAY TIE.—J. H. BARNES, 65 Broadway, Norwich, Conn. An object of the invention is to provide a metallic tie wherein the rail supporting or bearing blocks are secured upon the body portion of the tie in such manner that the same may be readily removed and replaced when worn, thus obviating the necessity of replacing the entire tie. Another object is to provide an effective lock for securing the bearing blocks in operative position on the tie.

AUTOMATIC BALL BEARING SIDE BEARING FOR RAILROAD TRUCKS.—G. M. HYNDES, 1719 So. Lamar, Dallas, Texas. The invention has for an object the provision of means associated with a side bearing whereby the shock of the weight of cars on the roadbed and rail joints is efficiently reduced, so that the necessity for repairing the bed and the joints is greatly reduced.

AUTOMATIC LOCK FOR RELEASE VALVES.—R. L. LABACHOTTE, 109 Brewster Ave., Redwood City, Cal. Among the objects of the invention is to provide an automatic lock particularly designed to be used in combination with the release valves of an air brake, and to provide means for locking the valve in its released position so that it is only necessary for the operator to open the valve, the latter staying open thereafter, means being provided in the air brake for causing the piston to return as the pressure is released.

Pertaining to Recreation

GAME APPARATUS.—J. A. ERNST, JR., 98 North Ave., Ridgefield Park, N. J. An object of this invention is to provide a game apparatus in which a game such as baseball is played and in which the success of the game depends largely upon the skill of the operator in the manipulation of the apparatus. A further object resides in the provision of means whereby the progress of the game may be very easily and plainly recorded.

MARBLE SHOOTER.—J. S. JAFFE, 388 Sherman Ave., New Haven, Conn. An object of this invention is to provide a toy which is shaped like a pistol and which is adapted to project a marble or other similar projectile with some force from the forward end of the shooter. A further object is to provide a marble shooter with projecting mechanism, which will be strong and durable and can be manufactured at a relatively low cost.

ADVERTISING TOY.—C. W. KUEN, 1520 Edgewater Ave., Chicago, Ill. An object of the invention is to provide a device of the character described, the use of which will not only afford entertainment, but will serve as an effective advertising means, in which the name of an article is revealed a portion at a time as the game progresses. If a player is successful the entire name of the goods advertised will be revealed. An ordinary pair of dice are used as counters.

TOY PISTOL.—L. S. BIXLER, c/o Kenton Hardware Co., Kenton, Ohio. An object of the invention is to provide a means for preventing injury to the operator, due to backfire or flash, when the pistol is operated to explode a paper cap. Another object is to insure the explosion of a cap by the provision of anvil and hammer, the former of which is designed to receive and properly position the cap in the path of the movement of the striking face of the hammer.

Pertaining to Vehicles

LOW PRESSURE ALARM FOR PNEUMATIC TIRES.—W. A. HARRIS, c/o Harris Accessory Co., Greenville, S. C. The invention relates generally to low pressure alarms for the pneumatic tires of automobiles and other motor cars. In this construction the movement of the stem is limited so that it can only seat at its inner end with sufficient pressure to be airtight, the parts of the device may be properly adjusted with ease, and while being constructed to prevent accidental displacement, it may be readily removed by one understanding the structure.

AUTOMOBILE LOCK.—S. B. CLAYTON, 432 Church St., Greensboro, N. C. The object of the invention is to provide a locking device which is adapted for use with various types of steering mechanism and in which the lock mechanism is embodied in the lock itself and is protected without in any way impairing the capability of the lock, the device being at the same time of simple and durable construction and reliable in operation, and inexpensive to manufacture.

CURTAIN CARRIER.—E. E. LAMICA, c/o Whiteside Cafe, Chester, S. C. The invention relates to curtains for vehicles provided with tops. It is an object to provide a simple and efficient means for supporting curtains above the doors of an automobile or like vehicle, so that the doors and the side curtains can be swung from open to closed position or vice versa without the necessity of detaching any part of the side curtains from a support.

EMERGENCY BRAKE LEVER.—O. W. POPE, 1608 W. 28th St., Oklahoma City, Okla. Among the objects of this invention is the provision of a readily accessible emergency brake lever for applying the brakes to the rear wheels of a four door Ford sedan, a two door coupe and a Ford delivery car, with the lever being so positioned that the same will not inconvenience the occupants of the front seats of the car, nor interfere with the operator of the car when entering or leaving.

DIRIGIBLE HEADLIGHT.—A. C. WOODRUFF, Burns, Ore. An important object of the invention is to provide a dirigible headlight having means whereby the lamps are simultaneously turned either to the right or left as the vehicle changes its direction of travel, also to provide means whereby the lamps may be tilted above a horizontal axis so that the rays will be directed downwardly or cast some distance in front of the car, as may be desired.

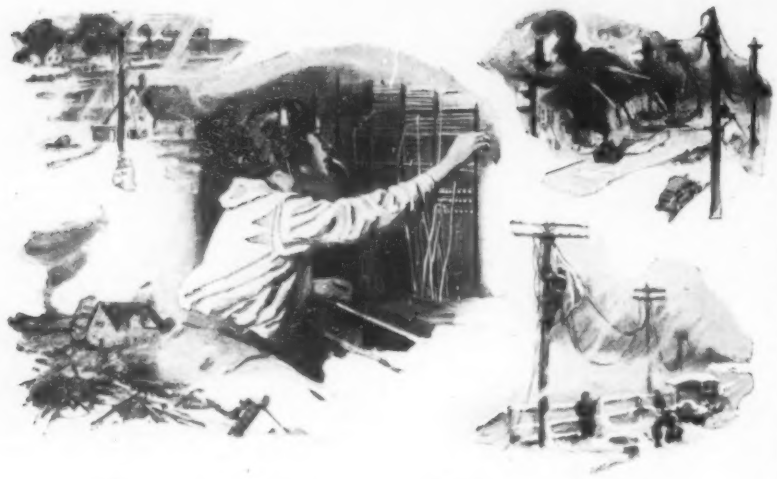
RADIUS ROD.—J. C. HALDEMAN, 96 Lincoln Ave., Salem, Ohio. The primary object of the invention is the provision of radius rods which may be readily utilized either in lieu or in addition to the usual radius rods, with a view of forming more substantial support and less noisy action, and a further object is the provision of a radius rod having means whereby its end connections may be easily and quickly adjusted at all times to avoid rattling and other noises.

GASKET PROTECTOR.—M. MCINTYRE, 139 Center St., Healdsburg, Calif. This invention is particularly designed to be used in connection with the transmission cover of a Ford transmission case. An object is to provide a protector for the edge of the gasket which will guide the transmission cover past the gasket and which can be withdrawn after the transmission cover is in place. The device comprises a strip of protecting material bent to overlie the edge of the gasket, and having a flange adapted to cover the face of the gasket.

SIGNAL.—T. I. and E. A. TEMPLE, 48 No. Orange St., Medford, Ore. An object of the invention is to provide a signal which is adapted to be positioned on the surface of the roadway so that its presence cannot be overlooked by persons traversing the roadway, and which in applied position, does not obstruct or hinder in any way the passage of vehicles thereover. The signal giving elements may be varied to suit the varying conditions of light or to give various signals to direct approaching vehicles.

DOOR OPERATING DEVICE.—C. L. MARSH, Bridgewater, S. D. The invention relates to a door operating device which is particularly adapted for use in connection with garages, etc. The invention aims to provide a door operating device by means of which an operator will be able to cause an actuation without alighting from the vehicle, the doors being caused to automatically open upon the approach of the vehicle and subsequently close after the vehicle has passed through.

SPRING MOUNTING.—V. W. PAGE, Victor Page Motor Co., Melrose Ave., Stamford, Conn. One of the objects of the invention is to provide a novel spring-attaching means for securing the rear end of the springs to the axle housing. A further object is to provide an arrangement whereby the working parts of the rear axle and spring suspension may be thoroughly lubricated.



Priceless Service

Despite fire or storm or flood, a telephone operator sticks to her switchboard. A lineman risks life and limb that his wires may continue to vibrate with messages of business or social life. Other telephone employees forego comfort and even sacrifice health that the job may not be slighted.

True, the opportunity for these extremes of service has come to comparatively few; but they indicate the devotion to duty that prevails among the quarter-million telephone workers.

The mass of people called the public has come to take this type of service for granted and use the telephone in its daily business and in emergencies, seldom realizing what it receives in human devotion to duty, and what vast resources are drawn upon to restore service.

It is right that the public should receive this type of telephone service, that it should expect the employment of every practical improvement in the art, and should insist upon progress that keeps ahead of demand. Telephone users realize that dollars can never measure the value of many of their telephone calls. The public wants the service and, if it stops to think, cheerfully pays the moderate cost.

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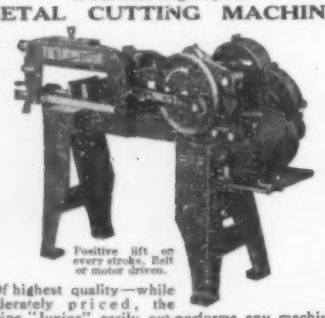

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The Scientific American Digest

A review of the technical and trade press, consisting of abstracts from leading articles announcing the newest developments in industry and engineering

Exact references to the sources from which these abstracts and quotations are made follow each abstract, the numerals referring respectively to the volume, number, and pages occupied by the original article in order that those who wish for further data may refer to the originals. Other digests ordinarily appear in Electrical Notes, Service of the Chemist, and other departments which are omitted from this issue

Automotive

Oxidized Kerosene as Fuel.—Experiments made by the research laboratories of the Carnegie Institute of Technology, Pittsburgh, have shown the relative efficiencies of oxidized kerosene and kerosene as fuels. Oxidized kerosenes cause less knocking tendencies than common kerosene when used in kerosene engines. It was also demonstrated that oxidized kerosenes have about the same power potentialities as ordinary kerosene, even though their thermal values are one-eighth less. This anomalous condition is due, it is thought, to the better clean-up in the combustion of partially oxidized fuels. The successful outcome of this work promises that oxidized kerosene, which is manufactured from low-grade petroleum by catalytic oxidation, may become a useful fuel in the future. Owing to its properties it may come to be used industrially in kerosene engines, or as a blender with gasoline for use in gasoline engines.

Knockless Gasoline developed by the General Motors Research Corporation in connection with Massachusetts Institute of Technology is on the market in one state and will be available all over the country as soon as production can be increased. If certain knocks are caused by a high-pressure, high-velocity wave striking the top or sides of the combustion chamber then suppressing the knocks is a matter of suppressing this wave. The addition of 40 to 60 per cent of benzine or alcohol accomplishes this purpose, but there is not enough of either of these fuels to "doctor" all the "gas" which we now use at the national rate of a 10,000-gallon tank-car per minute. Research showed that the knock could be suppressed by the addition of very small amounts of diethyl telluride, one volume of this material being equivalent to 250 volumes of benzine as an anti-knock material, while one volume of lead tetraethyl equals 625 volumes of benzine, in the same manner. The new product is called "ethyl gas."—*Tech. Eng. News*, 4:6, p. 210.

Performance Tests on Automobile Tire Casings conducted by the Bureau of Standards show some remarkable results. In practically all cases the coefficient of friction at the start of motion is less than that during continuous motion—a result which is quite different from that usually applying in tests in which friction coefficients are measured. On clean wetted surfaces, the coefficient is, in some cases, higher than on the same surfaces dry. This is true on concrete and in some cases on asphalt. James is of the opinion that the slippery conditions often encountered on hard surface roads, especially when they are wet, is due to the presence of a film of some foreign substance which, in effect, acts as a lubricant. Coefficients as high as 0.80 are quite general and of 0.90 or above not at all unusual. The coefficient was 1.00 on one piece of rough concrete and actually reached 1.16 on dry plate glass in one case! The lowest coefficient found on any road surface among those tried was 0.54 on wet oiled asphalt. Friction in motion transverse to the plane of the tire is usually about the same as that parallel to the plane and the configuration of the tread appears to have little if any effect on hard surface roads. It was found, however, that composition of tread rubber had a marked effect upon coefficient of friction on hard smooth surfaces.—*Automotive Ind.*, 49:22, pp. 1091-96.

Means for Increasing the Yield of Gasoline from crude oil by the application of cracking methods have recently been devised. Depending upon the original character of the oil, this increase may be as much as 13 fold. The oil is heated to about 875 degrees Fahrenheit under 500 to 600 pounds pressure while circulating through tubes in a furnace, and flows to a large insulated cylinder where the completion of the cracking operation takes place. This cylinder, or reaction chamber, must stand heat, pressure, corrosion by sulfur in the oil, and be absolutely leak proof, for the gasoline under high pressure is well above its ignition point. The use of forged steel cylinders for this purpose has met with signal success.—*Iron Age*, 112:18, pp. 1175-76.

Industrial Progress

The Cotton Manufacturing Center of the Country is today in the South. It now produces considerably more than half of the cotton cloth made in the country. Up to a short time ago cotton cloth could not successfully be made, except in certain localities where the air was sufficiently moist and humid. That is why Massachusetts and Rhode Island, with their broken coastline, and numberless lakes and rivers resulting in constantly humid atmosphere, became the center of the cotton industry in this country, precisely as Lancashire, for similar reasons, grew to be the center of the industry in England. No attempts to spin cotton in the South were successful until the humidifying apparatus was discovered. This permits the fibers to be picked, drawn and spun properly. Mill expansion in the North has been practically non-existent for the last two years. A great deal of Northern capital has been put into Southern cotton mills, and doubtless more will go in the same direction, but so long as the mills in North and South Carolina and Georgia can produce more efficiently than those in the Bay State and Little Rhody—most of the money invested in the cotton business will be apt to go South.—*Ind. Digest*, 2:10, pp. 750-51.

Through Electro-deposition, metal patterns are made very accurately owing to the fact that there is no shrinkage involved. Since these patterns are exact duplicates of the original in size, shape and finish it is obvious that machining, filing, and scraping are practically all eliminated. Patterns can be made of copper, brass, nickel, or any other metal or combinations of metal (for example, a nickel surface with a copper backing). The method of procedure is similar to that used in electrotyping. Casts of wax, plaster of paris, or any fusible alloy are taken of the desired pattern to be reproduced. These casts are made conductive on the impression surfaces. In the case of wax or plaster of paris, graphite is used to make the conductive surface. Contact wires are inserted in the casts to make a connection in the plating tank and conductive surface of the cast. Suitable insulation is given these casts to prevent the metal from spreading on the non-conductive surfaces. These casts are then placed in the desired plating solutions, and are allowed to run until the desired thickness is obtained. The casts are taken from the bath and the metal deposits removed. They are backed up with some suitable alloy, such as white metal, to give strength, if necessary. The partings are then checked very closely and machined or ground off, if required, and from this point the procedure is identical with the old method. This method is filling a long-felt want in the foundry and is perhaps the one big advance step made in the producing of metal patterns in the last 25 years.—*Metal Ind.*, 21:12, p. 499.

The Mercury Vapor Boiler provides for the vaporization of mercury, expanding it through a turbine and utilizing the heat of the exhaust to generate steam from water, this steam being put through a separate turbine. That is, the mercury condenser surface is the steam boiler. In this way advantage is taken of a much greater temperature range than is possible with steam alone, and the thermal efficiency approximates that of the internal combustion engine, namely, one kilowatt-hour at about 11,000 B.t.u. If

(*Continued on page 124*)

A Radio Statement to the Public

The Meaning of Coordinated Scientific Research

KEEPING its pledge to the public, the Radio Corporation of America has concentrated its vast research and engineering forces upon the solution of certain fundamental problems facing the art—problems which have become more apparent as broadcasting stations and radio receivers multiply.

The phenomenal expansion of the radio industry, and the universal and ever-increasing appeal of radio represent an outstanding development of the present century—for this industry has grown from infancy to maturity in a space of but two years.

• • •

Briefly stated, there is today a necessity for

—***A radio receiver providing super-selectivity*** —the ability to select the station you want—whether or not local stations operate. A selectivity which goes to the theoretical limits of the science.

—***Super-sensitiveness***—meaning volume from distant stations—along with selectivity.

—***Improved acoustics***—more faithful reproduction of broadcasted voice and music than has ever been possible before.

—***"Non-radiating" receivers***—a new development, a type of receiver which, no matter how handled, will not interfere with your neighbor's enjoyment.

—***More simplified operation***—a super-receiver requiring no technical skill, thus making the greatest achievements of entertainment immediately available to all members of the family.

—***A receiver for the apartment house*** and populated districts, requiring neither aerial nor ground connection.

—***Another type of improved receiver for the suburban districts,*** equally capable to that above, for use where the erection of an aerial presents no problem.

• • •

Painstaking search in quest of these ideals has led to new discoveries setting new standards of excellence and performance—discoveries which have established

First—that improved acoustics are possible—a matter of scientific research and not of haphazard design—for truly melodious reception.

Second—that dry battery operated sets can be so designed, as to give both ***volume*** and distance.

Third—that the regenerative receiver is susceptible to marked improvement providing selectivity, sensitiveness and simplicity of operation hitherto deemed impossible of accomplishment.

Fourth—that the Super-Heterodyne—the hitherto complicated device requiring engineering skill to operate—could be vastly improved—improved in sensitiveness and selectivity—and simplified so that the very novice and the layman could enter new regions of entertainment and delight.

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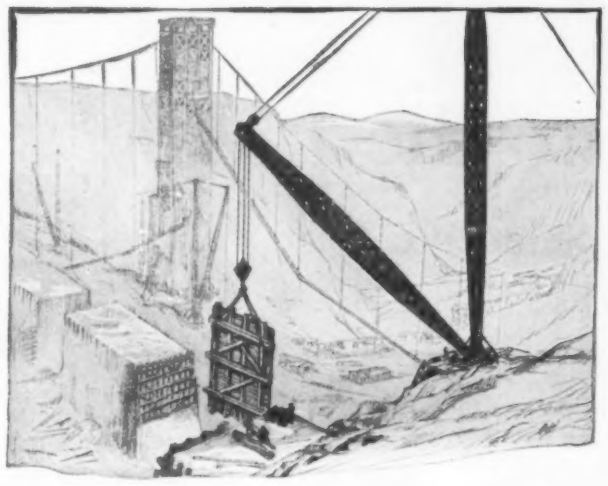

Dam Building

Industry and irrigation have compelled the building of innumerable dams all over the country—huge ones that impound millions of gallons of water, and little ones, not much larger than the old time miller's dam that provided power for his mill as well as a good place to fish.

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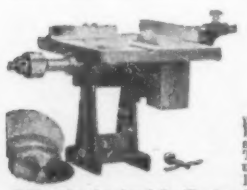

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Scientific American Digest

(*Continued from page 122*)

we compare the mercury vapor process with a steam generating plant running at 200 pounds steam pressure and with the higher standards of efficiency in turbines and auxiliaries the mercury-steam combination with mercury at 35 pounds gage, should, according to one writer, give about 52 per cent more output in electricity per pound of fuel. And if in such a plant the boiler room is re-equipped with furnaces and mercury apparatus arranged to burn 18 per cent more fuel, the station capacity with the same steam turbines, condensers, auxiliaries, etc., would be increased about 80 per cent.—*Power*, 58:23, pp. 876-80.

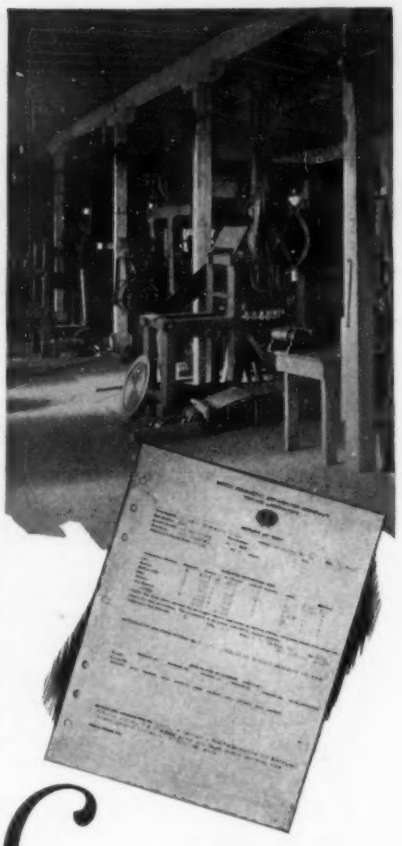
Electrofanned Hogs represents the latest advancement in the use of electricity for every conceivable purpose. On the 101 Ranch, now the largest ranch in the United States, the head of a large herd of fancy hogs, known as "The Great I Am," has a special home with a device on which he has merely to step, causing a large electric fan to be switched on. Stepping on another board electrically turns on a showerbath. In several small maternity houses for the sows, provision is made for electrically heated pads which are used when pigs are littered during cold weather, to keep the new-borns warm. Power is generated by a 100-horsepower Diesel engine for which the oil is produced on the ranch, which lies within the Oklahoma oil field. Natural gas secured in a like manner is used under boilers to generate steam. Electric light is used to lengthen the working hours of hens, thus increasing the egg output.—*Mfr's. Record*, 84:21, p. 69.

The Use of Bituminous Coking Coal as Water-gas Generating Fuel is found to be unquestionably preferred to that of coke at its prevailing high price, according to investigations made by the Bureau of Mines. Central district bituminous coals have been used to some extent during the past few years in Illinois and surrounding States as water-gas generator fuel. As prices of coal and coke advance, with an increasing margin of difference between them, the economy that can be realized from the use of coal as generator fuel increases. When coal is substituted for coke and the same methods of operating used as with coke, there is an appreciable waste of fuel, which can be eliminated. The amount of this waste per thousand feet of gas made will increase as the standard of gas is lowered. The present tendency is toward a lower standard for city gas. One method of eliminating waste—the use of a waste-heat boiler with combustion chamber—is suggested and discussed in Technical Paper 274, by W. W. Odell, fuel engineer, which may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

The World's Nitrogen Consumption increased between 1913 and 1918 from 808,031 to 1,285,398 net tons, or 59 per cent, the proportion derived from Chile and from coal decreased, while that of fixed atmospheric nitrogen increased until the atmosphere supplied a greater percentage of the nitrogen consumption than either of the other sources. The fixed nitrogen industry was thus established in the world and in 1922 we find the consumption of 875,000 net tons of inorganic nitrogen made up of 24 per cent from Chilean nitrate, 35 per cent from the coke and gas industry and 41 per cent from the atmosphere. In the United States in 1922, 179,000 net tons was used, with production from coke and gas of 58 per cent and atmospheric plants 3 per cent of this amount. In the peace-time development of actual producing plants for nitrogen fixation the United States has taken practically no part, less than 3 per cent of our present requirements being supplied by the fixation of atmospheric nitrogen within our borders. The United States Nitrate Plant No. 2 at Muscle Shoals has 40,000 tons capacity, which shows that even though the Muscle Shoals plant were now operating we would then be producing but 20 per cent of our annual consumption in fixed nitrogen. It is quite evident that no large nitrogen industry exists in this country today.—*Chem. and Metall. Eng.*, 29:24, pp. 1047-50.

A 22,000-Volt Electric Steam Boiler has recently been installed in a plant at Berlin, N. H. It is an 1800-horsepower boiler operating at 135 pounds gage pressure, and its use takes the place of 69 long tons of coal in a day of 23 hours—coal worth $550 under the boilers it displaced. The unique feature of the installation is the very

(*Continued on page 126*)



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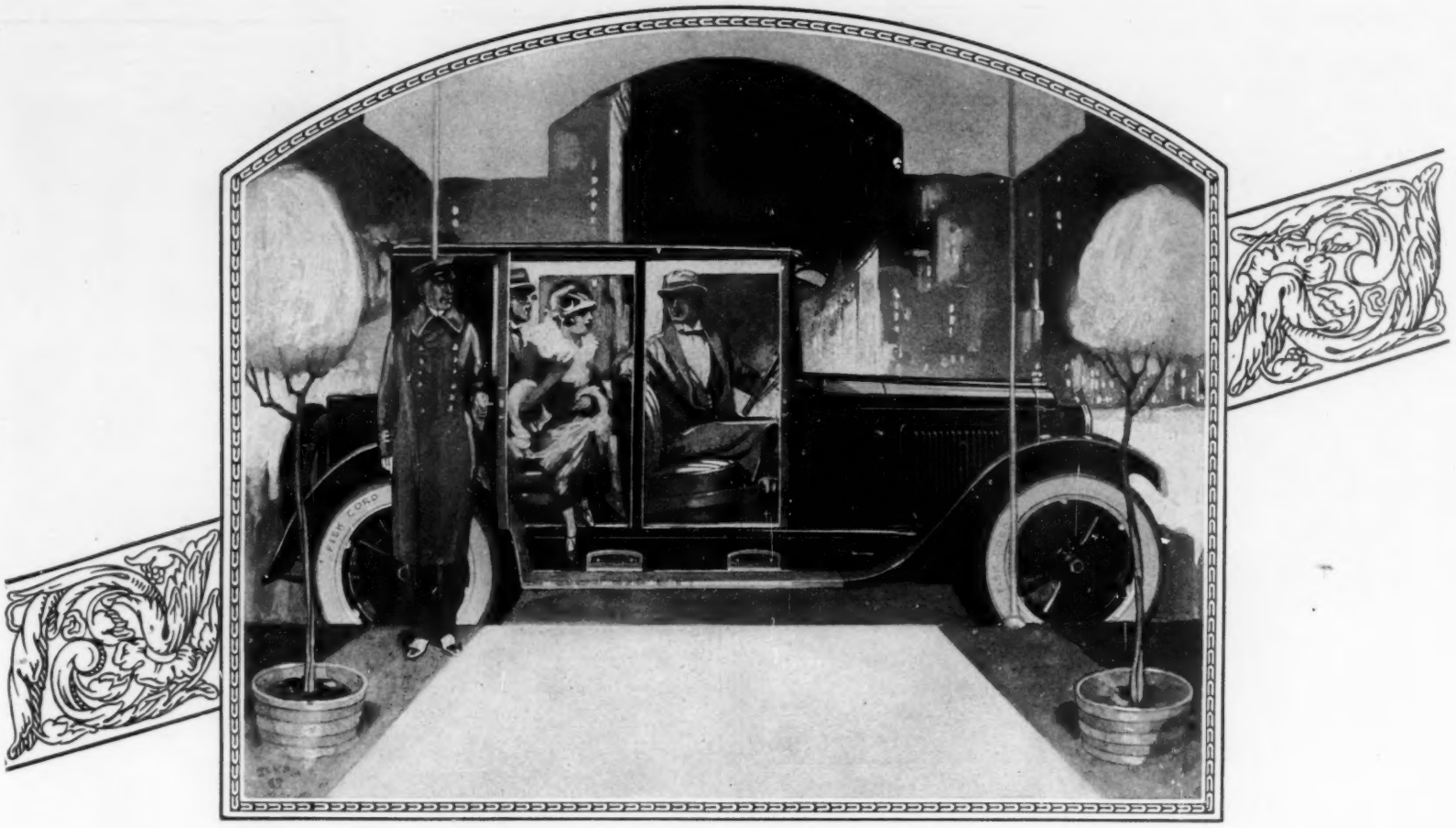

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Scientific American Digest

(*Continued from page 124*)

high voltage used without a step-down transformer. It was found that the necessary transformers would have been twice that of the transformers themselves, and since this installation was intended to be used only to hold steam over each Sunday in a plant where continuous steam was necessary to a paper-making process, this would have been prohibitive. But no electric boiler of such high voltage had ever been built or even attempted. The installation is considered to be a most successful venture, the difficulties which had been anticipated not having materialized. The matter of insulation of the conductors where they entered the tanks, the feared inability to operate at low load, and the rapid wear of electrodes turned out to be needless worries. The cost of installation was $25,000 and it will have returned its entire capital cost in only 46 days. This is largely due to block rates for Sunday power.—*Engrs. and Engineering*, 40:11, pp. 290-91.

St. Louis is to Become a Steel and Iron Center, following the development of a new ore field near that city, according to *Manufacturer's Record*, a magazine devoted to the building up of industry in the South. There is produced within a radius of 100 miles of the city of St. Louis every necessary basic material, including a portion of the iron ore, the coal for making metallurgical coke, limestone and other raw material, and there now is growing in and around St. Louis a sea of smokestacks over the plants that have been and that are being erected for the purpose of utilizing the iron and steel. All of the basic material is produced along the lines of the Missouri Pacific Railway. The surface outcrop at Iron Mountain extends 8000 feet in the shape of a horse-shoe, going downward approximately 1000 feet with an average thickness of 10 feet. Besides all this the primary ore apparently is present in vast quantities. The vein already has been cut a distance of 224 feet, disclosing a potential tonnage greater than the approximate 4,000,000 that was taken from the mountain prior to 1920. There is available in the St. Louis district everything necessary for the development of a great iron and steel center. The Eastern Central coal field lies directly to the east.—*Mfr's. Rec.*, 84:21, pp. 57-61.

Mechanical Engineering

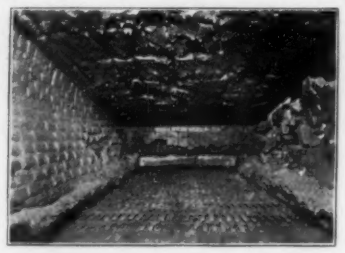
A Revolution in the Construction of Power Plants has taken place within the past few years. The reciprocating engine of 10,000 horsepower has given way to the steam turbine of 87,000 horsepower. The public service steam boiler of 350 pounds pressure, of which a few were built in 1922, is succeeded in 1923 by the boiler of 1200 pounds pressure. The 1500-pound boiler is under consideration here, and an experimental boiler for 3200 pounds pressure is building in England.—*Iron Age*, 112:18, pp. 1175-76.

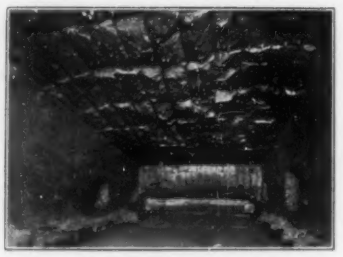
The Manufacture of Hardened Steel Rolls Has Recently Undergone an Active Development.—Formerly, nearly all cold rolling of strip and sheet metal was done with chilled iron rolls. In steadily increasing volume these are being replaced by heat-treated, hardened, slightly drawn, ground and polished rolls of alloy steel, usually chromium, chrome-vanadium, chrome-molybdenum, chrome-vanadium-molybdenum, or chrome-tungsten-vanadium. Fully hardened rolls of these alloys may be made much harder than chilled iron rolls; the hardness runs in the neighborhood of 110 to 115 scleroscope. They take a much higher finish, produce a correspondingly better surface on the product, and are reasonably long lived if treated properly, as they deserve to be, for they are among the highest expressions of the steel maker's art.—*Iron Age*, 112:18, pp. 1175-76.

The Manufacture of Crankshafts has been much facilitated by a new machine tool invented in Denmark. It consists of two opposed milling heads on horizontal shafts carried by housings, each with three adjustments and feeds at right angles to each other. Between them, over a pit, is a driven table provided with vise jaws adjustable toward each other and with reference to the axis of the table. Clamped between these jaws in a vertical position, adjusted properly with reference to their axes, the pins and webs of a crankshaft can be machined all over by the revolving cutters controlled by the feeds provided by the housings or by the revolution of the table. There results

(*Continued on page 128*)

The first photo below shows a firebrick lining after a period of service. The second shows a Plibrico Lining after same service.





Just one difference

the lining—

ONE difference but what a vast difference it is!

In the upper photo, the crumbled side wall is an unanswerable argument against laid up firebrick; below, the staunch, *jointless* walls are a sermon for Plibrico.

Both photographs are of the same furnace, taken after the same amount of the same kind of service. And the result is no reflection on the quality of refractory used in the brick furnace. *The trouble started at the joints.*

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Firm .....

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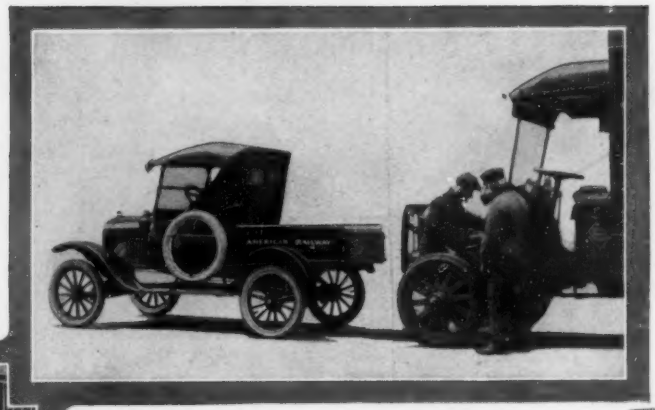

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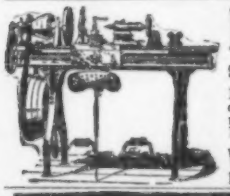

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Scientific American Digest

(*Continued from page 126*)

a great economy of time in the machining.—*Iron Age*, 112:18, pp. 1175-76.

Saving Worn Parts by Electrodeposition is a process which has been developed by the Westinghouse Research Laboratories for building up shafts, pins, bolts, gear centers and similar parts and which can be used for building up the worn bores of automobile engine cylinders. Commercial salts are used and a current of sufficient density is employed to permit all ordinary repair work to be removed from the plating bath at the end of two or three hours. The cost of building up and machining is kept low enough so that it will pay to reclaim a piece with this process rather than use a new one. While the research work has been carried on, over 200 pieces have been recovered for the Westinghouse plant, thus making the process help pay for its own development. This company is now installing a service station in the Pittsburgh district to handle all kinds of work that can be reclaimed by electrodeposition. A plating bath made up in the following proportions has proved best: 2.5 pounds of commercial ferrous ammonium sulfate per gallon of city water plus a small amount of ferrous carbonate (freshly precipitated and kept under water in order to keep the solution practically neutral) plus a small amount of powdered charcoal, which helps to prevent pitting. The equivalent amounts of commercial ferrous sulfate and ammonium sulfate may be substituted for the ferrous ammonium sulfate. If the solution is made up from the ferrous sulfate and ammonium sulfate, the granular or "crystal meal" ferrous sulfate should be used. The ammonium sulfate must prove to be free from sulfocyanate when tested with ferric-sulfate or ferric-chloride.—*Brass World*, 19:11, pp. 373-75.

High Steam Boiler Pressures are a post-war development, and at present there is a wide difference of opinion among engineers on this question. Some look on it as a natural development, and others as a passing fad. In this connection it must be remembered that if the total temperature is fixed, any increase in pressure means a decrease in superheat. For example, with 750 degrees maximum temperature there would be 360 degrees of superheat with 200 pounds pressure; 300 degrees with 400 pounds; 184 degrees with 1200 pounds; and only 40 degrees at the critical pressure of 3200 pounds. At the present time the steam pressure in a great majority of commercial plants does not exceed 250 pounds. A small number of plants are operating in the range from 250 pounds to 600, and perhaps a half dozen others are under construction at the present time. So far as can be determined no American boiler has been in operation for long at pressures above 600 pounds. After a few high-pressure plants have been in operation more will be known of the actual results from their use, and it is altogether probable that steam pressures of 800 pounds and upwards will, when combined with reheating and back pressures, be found advantageous from a broad economic standpoint.—*Power*, 58:24, pp. 966-67.

A New Form of Heat Treatment Bath in which tools or parts may be treated in the finished shape without deformation, oxidation or decarbonizing has been developed. The base of the molten bath is understood to be treated lava, which is supplied in metal containers. When heated to the proper temperatures, these materials form mobile liquids of high specific heat and of a specific gravity of only about one-sixth that of the lead bath. No hood or ventilation system is required, as no fumes are evolved. Heat treatment of parts, such as gears, piston pins, tappets, bearing races, drop forging dies and die casting dies and production treatment of edged parts like scythes, auger bits, etc., has been accomplished with unusual success by the use of treated lava. This process was developed during the war for the heat treatment of small ordnance parts. As the material is neutral to steel, no scale of any kind forms and production is greatly increased. This property, together with the ability to form protective coating over the parts as they are put in the bath, allows the treatment of completely finished parts. As the parts are taken from the bath, a protective coating is again formed, preventing oxidation while parts are transferred to the next bath. This protective coating, together with the turbulence of the mobile liquid due to convection currents, causes uniform heating of the part in the bath and therefore eliminates distortion.—*Automotive Ind.*, 49:23, p. 1147.

Electric Furnaces far outclass the best production practice of any of the combustion furnaces in every factor, and from every standpoint, except perhaps the first cost of the installation. They greatly simplify the labor problem and render the manager independent of the melter. They permit the routine repetition of the melting schedule, which has been reduced to the mere charging of the metal into the furnace, stirring and skimming it if necessary and, when melted, pouring it. The time and temperature of pouring are decided by pyrometer and can be placed under the eye of the manager or superintendent at all times. It is conservative to say that the metal can be melted for half the cost of that of combustion furnace practice, considering the cost of fuel, metal loss, upkeep, etc., and this, not considering the indirect savings in the improvement of the product, uniformity, reduction of rejections, satisfaction of the customer, savings in floor and storage space, absence of worry, and so on. The improvement in working and sanitary conditions in the foundry, brought about by the use of the electric furnace, are highly important items, there being absence of noise, heat and fumes. There are four principal types of electric furnaces in use in this branch of melting: the open arc, the muffled or smothered arc, the resistance and the induction furnaces.—*Iron Age*, 112:19, pp. 1283-86.

Metallurgy

Dirty Steel gives far less uniform results on endurance tests than cleaner steel, and dirty steel is certainly unreliable and unsafe when repeated vibration must be endured. These inclusions, or other similar inhomogeneities in the metal are probably the cause of many failures in service. The endurance properties of any really clean steel may be quite safely predicted, according to conclusions drawn from tests made by the University of Illinois in cooperation with the Bureau of Mines of the Department of the Interior. But when the steel is not clean, it may either give the same results as a clean steel or far poorer results, depending on whether the most severely stressed spot in a piece made from the dirty steel happens to be locally clean or locally dirty. According to these investigations, cerium offers no promise of usefulness as an alloying element in steel. Its use tends towards the presence of nonmetallic inclusions and toward troubles consequent upon this defect.—*Iron Age*, 112:20, p. 1330.

American Graphite as compared with the imported material was the subject of experimentation made at the plant of two users of graphite crucibles. It was found that Alabama graphite bonded with the American clays gave superior service, a service at least equal to the commercial crucibles of the same class which have been sold on the open market. Ceylon graphite which is considered by many manufacturers to be best for crucible work, was third in the list of tests and Canadian graphite which had been recommended very highly because of its structure, was last in the list.—*Metal Ind.*, 21:12, pp. 477-78.

The Deposition of Chromium on Metals by Electroplating is exciting some interest in Great Britain and the subject is under investigation at some of the Sheffield works. Some doubt is felt as to the commercial possibilities of the process. Chromium is four times as costly as nickel but that would not be a serious factor provided the operation of plating does not prove to be more expensive. Chromium is said to give a much more durable surface and there is said to be a substantial saving in time and labor, as plating with chromium occupies only one-third of the time taken for the deposit of nickel and the articles come out of the solution in a highly polished state. Lead anodes can be used and these do not deteriorate in the solution. It is asserted that an ample coating of chromium can be deposited on brass in two minutes and that as the copper does not penetrate the chrome there is no necessity for subsequent buffing. The chromium, it is claimed, is also so worked into the base metal that rust cannot settle between the two.—*The Metal Ind.*, 21:12, p. 488.

Molybdenum was first tested in rolls during 1920. Since then compositions of varying analyses and uses have been developed. Molybdenum is now used in all the four classes of rolls, namely: Low-carbon steel, high-carbon steel, iron cast in sand molds (sand rolls), and iron cast in metal

molds (chilled rolls.) For the severe service in blooming mills and roughing mills, the low-carbon steel molybdenum roll was developed, yielding a high degree of strength, toughness, and wear. Analyses and treatments of alloy steel and alloy rolls have received a new impetus. It is true that molybdenum is a contribution in this progress backed by sound reasoning and splendid service. The data so far gathered from hundreds of molybdenum steel and iron rolls and repeat orders from many steel mills are definite evidence of the merit of molybdenum as an alloying element in rolls. With the experience that has been gained during the past three years it is only logical to expect further advances and a solution of problems which will benefit the industry as a whole.—*Iron Age*, 112:23, pp. 509-10.

Adding Nickel to Babbitt Metal is not justified on the customary basis. It has been the practice of some engineers and manufacturers to add nickel to white anti-friction or bearing metals but the actual object of this has been the subject of some controversy. It has been largely held that the original idea was not a metallurgical or even an engineering one, but to provide a means of identification of a certain manufacturer's metal after the bearing had been cast. The practice was adopted in other quarters, thus destroying the original object of providing identification. As excellent alloys were so treated, some virtue gradually became attached to the nickel content. Lengthy tests made in England, and presented to the British Institute of Metals now make it appear that the presence of a small quantity of nickel has the effect of combining with or dissolving in the copper present, and that the copper-tin compound is suppressed; hence the alloy loses that valuable property of resistance to crushing which it appears to owe to the interlocking of the copper-tin compound in its dentritic form, and the hardening effect, if any, of the nickel does not compensate for the loss of this form of structure. Thus it would appear that the addition of nickel in such proportions to alloys of this character does not justify itself.—*Metal Ind.*, 21:11, pp. 433-34.

The Soderberg Electrode is widely used in Europe in electrothermic industries. It has demonstrated its value in tilting electric steel furnaces and will also be a contributing factor toward cheaper electric steel. This method of forming the electrode in the same furnace in which it is used was at first frowned upon. With the improved understanding that has come from experience, the technical problem of the self-baking electrode has been solved. Numerous carbide and ferroalloy furnaces in Norway, Sweden, and Germany have been enjoying the savings which the continuous self-baking method makes possible, for several years past. The Mitsui Co. recently purchased the rights for Japan and is using Soderberg's in carbide furnaces, totaling more than 60,000 kw. capacity. In France, Italy, and South Africa, plants are now in operation using this method. Several plants abroad are already using with considerable success a process consisting of blast furnace metal to metal mixers, metal mixers to Bessemer, and Bessemer to electric furnaces—eliminating entirely the open-hearth furnace. Cheap steel of high quality and uniformity can be produced by this process at a cost comparable with the cheapest production methods now in vogue. The amount and cost of electricity used is quite small and the introduction of the self-baking electrode, developed in Norway under the name Soderberg, not only will cheapen refining costs, but will render possible the design and operation of electric furnaces of very much larger capacity than any existing furnaces.—*Iron Age*, 112:24, pp. 1585-86.

Tellurium as an alloying material with steel was the subject of investigations made at Massachusetts Institute of Technology. This metal has not been one of the elements used for alloying purposes with steel. It does not tarnish in moist air, and this property may be of commercial importance. At present the uses of the metal are very limited, and the production is small, the possible annual supply from the copper refineries being only about sixty tons. The telluride of gold has been known by metallurgists for many years, and an iron-tellurium has been successfully made. Tests were made at an electric furnace where regular steel castings were being made. One thousand pounds of steel was tapped into the ladle and twenty pounds of metallic tellurium was added. Analysis shows that about 40 per cent of this was retained by the steel. The results showed a somewhat lower ductility than would be expected in a well-annealed steel casting with carbon 0.24 per cent, and an explanation was sought in the microstructure. The new constituent was seen, and has been provisionally called telluride of iron.—*Iron Age*, 112:24, pp. 1575-76.

The Prevention of Corrosion of Steel formed the subject of tests made at the Federal Laboratory for Tests of Materials at Zurich, Switzerland and the following results were obtained. Aqueous solutions of salts of chromic acid after reaching a certain concentration preserve iron from rust for an unlimited time without the protecting action of the solutions becoming enfeebled or exhausted. The passivity contributed to iron by these solutions only lasts so long as the metal is immersed in them. When added to these solutions, certain salts, notably the chlorides of the alkalies and alkaline earths, and also to an extent not quite as great, the sulfates of these metals, reduce, paralyze or reverse the protective action of the chrome salts, while other salts such, as for example, the carbonates of the alkalies and lime reinforce their action. The protecting action of the chromic acid salts is not exerted solely on all kinds of iron and steel but on other metals such as copper, tin, brass, bronze, etc., whether they are isolated or in metallic contact with iron. For instance, small samples riveted together have been immersed in a 2 per cent solution of bichromate of sodium and are as brightly polished today as at the start of the test. It is stated that numerous experiments extending over six years have shown that a solution with 0.1 and 0.2 per cent potassium or sodium chromate rendered slightly alkaline with sodium carbonate, suffice in most cases to protect iron and steel from rust.

The Use of Oxygenated Air in metallurgical processes is being investigated by a committee which is sponsored by the Bureau of Mines. This committee has developed plans for experimentally determining the effects of oxygen-enriched air on the operation of the blast furnace, and has recommended that these plans be put into effect as the first step of an extended research on the general applicability of oxygen in metallurgy. The findings of the committee on these theoretical studies are revolutionary. After a critical review of the facts, the committee concluded that, in the present method of smelting iron, it will be practical to increase the oxygen content of the blast 21 per cent to 31 per cent and that this enriched blast, when fed to the furnace cold, will increase the production of the furnace by 18 per cent and decrease costs by 6.7 per cent. The study of this problem has firmly convinced the committee that with the application of oxygen to present blast-furnace practice the cost of production will be decreased; the output per furnace will be increased; closer chemical control will increase the uniformity of the product; cheaper materials, ore of lower iron content and coke higher in ash, can be used; and, it is believed that the sulfur content of the iron can be reduced. This rendering available low grade and previously wasted ores will in the end mean the highest type of conservation and conservation at a profit.

The Early Claims for Molybdenum as a specific against fatigue failure of steel, which alleged, directly or by inference, that molybdenum steels were vastly superior to other steels for uses to resist vibration, have not been substantiated in the over-enthusiastic form in which they were made. The Bureau of Mines' experiments show that, with one exception, molybdenum steels, and other alloy steels containing nickel, chromium, vanadium, or a combination of these elements, have equal qualities of endurance, and that no one alloy steel stands out above the others on this score. The exception is in favor of heat-treated molybdenum steels, for the presence of molybdenum makes the steel require a higher temperature in the drawing or tempering process after quenching, and this higher temperature causes fuller release of quenching stresses. The presence of quenching stresses tends to cause poorer performance under repeated vibration. This, however, is not a very great factor, and has a noticeable effect only in very hard steels, for example, those of spring temper. For ordinary structural uses, no alloy steel is appreciably superior for use against vibration to any other when the steels are used in such sizes that they harden throughout on quenching. Molybdenum and certain combinations of nickel and chromium confer depth-hardening properties on steel, and hence these have advantages for use in parts of large cross-section. Thus it is evident that, as regards endurance, molybdenum

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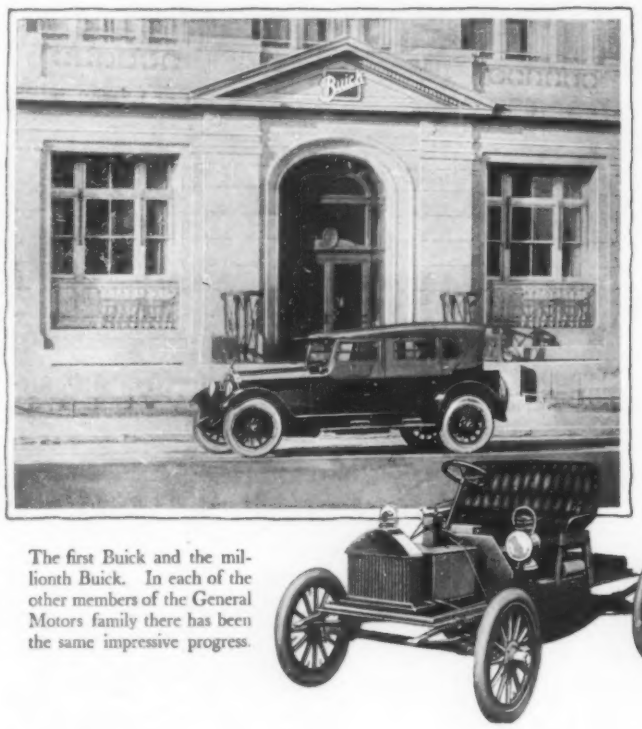

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steels are the equals of any, and on some scores have slight advantages, but the advantages are slight instead of large.

Mining

Perfecting the Centrifugal Mine Pump for Handling Acidulous Mine Water has been a development of the last 10 or 12 years. Along with this development the designer has been able to greatly increase his efficiencies until at the present time there is not the marked difference in that regard which formerly existed between the two types of pumps. Operating efficiencies of 70 per cent at 1000 g.p.m. and 80 per cent at 3000 to 4000 g.p.m. can be obtained with centrifugal mine pumps at the present time. The centrifugal mine pump also has evolved from a fairly complicated piece of machinery with diffusion vanes to a simple unit without diffusion vanes and few moving or wearing parts. The operation of the automatic centrifugal mine pumping outfit is as follows: A motor-driven vacuum pump controlled by a float switch in the sump is used for priming the centrifugal pump. Vacuum regulators, pressure regulators and bearing thermostats are used and connected in such a manner as to give ample protection to the pump and motor. The motor is protected against hot bearings, excessive overloads, failure of power and the pump against excessive suction lifts, air leaks, lack of priming or broken discharge lines.—*Coal Age*, 24:24, pp. 885-87.

The Recovery of Asbestos Fiber from its ore by a wet process instead of by the hitherto universally used dry treatment is the purpose of a new 25-ton-per-hour plant that is to be built at Thetford Mines, Quebec. If the claims of the company, based on work done during the past year in the specially built experimental plant are realized, this new process promises to revolutionize the asbestos industry. A peculiar feature of the asbestos industry is that there has been devised no method of "assaying" asbestos ore. In the first place, there is no known method of recovering all of the asbestos present in the rock, due to the fact that if the rock is pulverized sufficiently to release it, a part of the fiber is also reduced to dust. Another difficulty is due to the fact that long fibers have a higher value than short fibers; therefore, to "assay" the ore, it is necessary to know the length of all of the fiber as it occurs in the ore. No matter how carefully a small sample may be handled, there is apt to be some breakage of fiber, which would, of course, tend to reduce the value of the sample. The problem for operators, therefore, resolves itself into the question as to how much can be recovered from the ore, not in terms of fiber, but in terms of dollars. It is claimed that the process will recover from two to four times as much measured in dollars per ton as is recovered by dry methods from the same ore. This has been arrived at by comparing actual recoveries in dry plants with recoveries obtained on lots cut from the regular mill run. The selective-treatment process differs essentially from the method at present in use, in that it employs water as a medium of treatment. The ore is first broken in the usual way to reduce it to 2½- or 3-inch ring. A Marcy ball mill is then used for further treatment; it is contended that by proper regulation of the mill operation the asbestos is freed with a minimum of breakage of the long fiber. The mixture of fiber and rock is delivered to a special type of separator.—*Eng. & Min. Jour.-Press*, 116:23, pp. 696-97.

Ninety-five Per Cent Extraction of Coal-mine Pillars was made possible by a new method practiced in a Colorado mine. The new practice in pillar drawing is to maintain a parallel front on all the pillars in a given area that are in process of being cut back. The plan is to avoid leaving large stumps but to remove all the coal possible. The retreat is made by driving through the inner ends of the pillars and then running a series of short machine cuts across the end of each pillar until it is carried back thirty feet. This takes the place of the one long cut, which weakened the pillar from end to end. When the inner ends of a row of pillars have been cut back approximately thirty feet with faces kept at right angles to the line of the pillar, the bottom is shot up, props are pulled, some of them fit for re-use in spite of the heaving tendency of the bottom; the roof coal is brushed and the area left unsupported. In a short time the whole area caves, and the weight on the standing coal is greatly relieved. Then the pillars are ready for further drawing, men again re-enter the room with mining machines. Again the retreat is made toward the room necks. After each cave, of course, it is difficult to reach the tip end of the pillar. However, the next cut is started as close to it as possible and the stump that is left after a crosscut has been driven is small indeed, for if it were wide it would interfere with the next cave-in. Sometimes a shot is used to make the roof collapse. By this method recovery is brought up to its maximum. In spots it is almost complete; but 95 per cent is a fair estimate of the average recovery, according to the superintendent.—*Coal Age*, 24:19, pp. 695-96.

Centrifugal Concentration.—In connection with experimental work performed some time ago by the Reno, Nevada, station of the Bureau of Mines, on the concentration of a zinc descloizite ore carrying vanadium, a laboratory size centrifugal concentrating bowl was developed for extracting metals from the slimes that represented the major portion of losses in the table concentration of the descloizite ore. More recent experiments indicate that the bureau's concentrator may have a commercial application to a neglected field of metallurgy, the concentration of slimes that are not amenable to flotation, or that it may possibly compete with flotation itself in the treatment of some ores. Improvements evolved have been incorporated in a design for a small commercial machine with which further experiments may be conducted under plant conditions.

Conversion of Clays to Aluminum Sulfate.—In connection with the development of a simple cheap process of preparing pure solutions of aluminum sulfate, work has been undertaken at the Pacific Experiment Station of the Bureau of Mines on sulfating clays by various methods. Sulfate roasting, using gases containing varying amounts of sulfur dioxide to sulfate the aluminum silicate of the clays proved impracticable, but favorable results were obtained by treating the clays with sulfuric acid. A wide series of aluminum silicate products was treated at various temperatures with differing strengths of acid. In general, nearly all the silicates were decomposed with fair efficiency at temperatures up to 200°C and with acids containing 50 per cent to 70 per cent sulfuric acid. The easiest silicate to decompose was bentonite, but many of the kaolins were quite easily attacked. Feldspars are much more resistant.

Recovery of Zinc in Leaching Complex Ores.—It has heretofore been deemed impossible to leach an oxidized ore containing a large amount of zinc silicate with sulfuric acid. Research work performed during the present year by the Salt Lake City station of the Bureau of Mines has shown (1) that, by handling the oxidized ores with the sulfide, the mixtures may be made self-supporting as to acid when the zinc sulfate formed is electrolyzed; (2) by the use of leach liquors of proper acid strength throughout the process, any trouble due to soluble silica may be avoided. Practically this means that the present hydrometallurgical process for the treatment of zinc sulfide ores may be enlarged in its scope to include ores of almost any class, and thus that large amount of zinc, now being run into smelter slags at a great cost, may be saved.

The Application of the Chloride Volatilization Process to the recovery of metals from complex ores is being continued at the Salt Lake City station of the Bureau of Mines. Gratifying results have been obtained on two types of ores selected for experiment as being most amenable to treatment by this process. These are (1) "dry" silver ores whose high lime content renders them difficult to treat by the Holt-Dern process (chloride roasting and brine leaching) and whose base metal content would make the cyanide consumption prohibitively high for cyanidation; and (2) zinc sulfide flotation concentrates containing lead. The treatment for dry silver ores was successfully worked out in cooperation with a mining company on a semi-commercial scale, and a commercial plant is being planned. Experiments made by the Bureau of Mines with the zinc concentrate have shown that the lead may be almost completely removed by volatilization either as oxide or chloride. The work was checked by using representative ore from Butte, Montana, and from Nevada. The process was tried on a semi-commercial scale at Harbor City, California, and was found to be successful. It offers a ready means for the zinc retort plants to remove the lead from the concentrates before retorting, and for recovering the lead in a bag-house. Small shippers will also find they

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In the Work on Ore Classification problems in treating complex lead-zinc ores of the Coeur d'Alene and other mining districts of Idaho, an improved type of hydraulic classifier has been developed by metallurgists of the Department of the Interior attached to the Moscow, Idaho, field office of the Bureau of Mines. It is believed that this new classifier is more efficient than any now in use, and that it represents a distinct advance in metallurgical treatment. The new classifier has been tried out on a commercial scale in one of the mills, with the result that a greatly improved grade of classification is being effected. It is believed that table concentrations will be greatly improved when the tables are fed with good classified material. It also appears that with this type of classification, galena and sphalerite may be separated on tables into marketable products and that much of the fine grinding and difficult flotation treatment of complex lead-zinc ores may be eliminated.

Transporting Ore by Airplane with obsolete ships or military machines rebuilt into commercial carriers is a subject which receives a full analysis in *Eng. and Mining Journal-Press*, Vol. 116, pages 797-802. In an example given it was estimated that, assuming the distance between a mine and the nearest railroad shipping point to be twenty miles, two airplanes of the cantilever monoplane type with 200-H.P. motors should in an eight-hour day fly out with sixteen-unit loads of 1200 pounds each. Taking into consideration fuel consumption, depreciation, salaries, hangars and fields, and interest on investment, a total charge estimated at $88 a day, the cost of moving the ore would be fifty-five cents per ton a mile. Three planes would be required, allowing one in reserve; and it would be necessary to keep in employment one pilot, two mechanics and one helper. Undoubtedly there are many mining districts which are unproductive because of poor facilities for transporting high-grade ore over very inaccessible territory. It is certain that in some of them the cost of bringing ore out to the railhead would exceed the cost of airplane freighting.

The Geophone, which helped in stopping the underground mining operations of the Germans during the war, is now serving those who use explosives for purposes of peace. Until the geophone was invented the listening instruments were all electrical. The geophone is entirely mechanical. The inferiority of the electrical instruments is that they do not respond to the very faint sounds; a certain sound intensity is necessary before they will operate. With the geophone, sounds so faint that the listener has the sensation of feeling, rather than hearing them, can be detected and accurately identified. The geophone is essentially a small seismograph. It was invented by the French during the war and was developed by the United States engineers. When the instrument is placed upon the ground, the vibrations set up in the earth by any pounding or digging will rock the geophone. The case of the instrument vibrates with the earth. The heavy lead weight, suspended between elastic diaphragms, remains, because of its inertia, practically motionless. The relative motion thus set up between the weight and the instrument-case buckles the diaphragms and alternately compresses and rarefies the air in the top of the instrument. This air vibration is carried through the tube to the operator's ear. Geophones, for locating miners imprisoned after a disaster, are included in the equipment of the Bureau of Mines' rescue cars. They have proved to be of practical value for rough mine surveying, for bringing tunnels together, and for preventing accidents in blasting through. Successful results have also been obtained in locating leaks in water mains.—*Explosives Engr.*, 1:7, pp. 186-87.

That the Cost of Coal at the Mines may be reduced in many cases by 30 per cent is not theory but is based on a thorough analysis involving detailed time studies of the operation of loading machines, is the conclusion arrived at by Stanford E. Thompson and associates to the U. S. Coal Commission, summarized in several issues of *Coal Age*. This figure is conservative and is based largely on the use of the loading machine. If this method of loading is used, loading is performed at a fraction of the time and cost of hand loading; undercutting can be performed more systematically and

(*Continued on page 155*)

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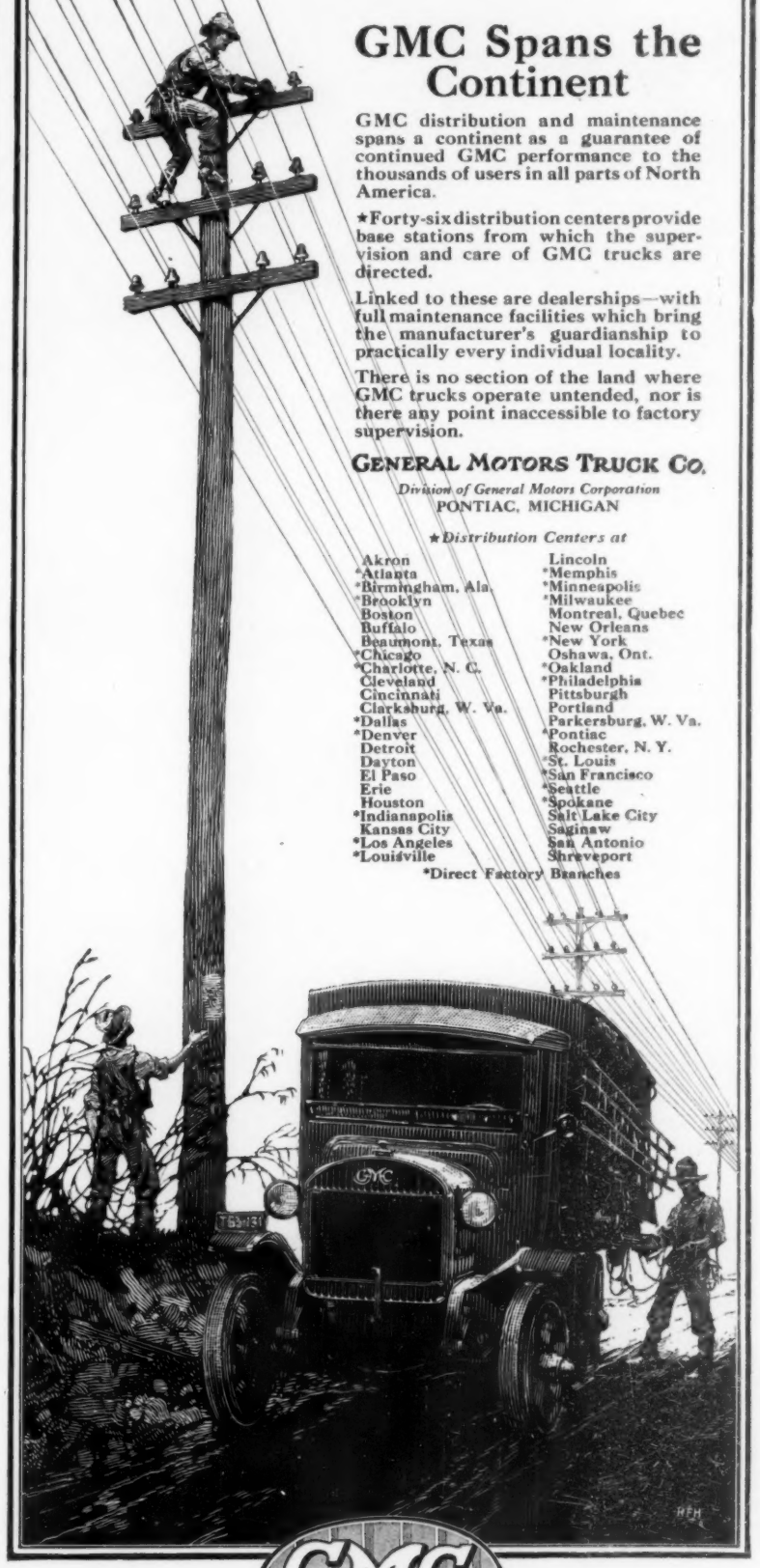

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Eucalyptus Oil as a Motor Fuel.—The Australian Commonwealth Government is interesting itself in certain experiments which have been made with the intent of using eucalyptus oil as a motor fuel. The experiments were performed by Captain C. M. Dyer, who claims to have established that eucalyptus oil can be used in gasoline engines, with efficient means of vaporization. The only difficulty is that it will not start an engine from cold without priming. On the other hand, the calorific value is high. Tests made with cheap cars are reported to have shown that a run on gasoline gave twenty-four miles to the gallon. When the cars were run on a mixture containing half gasoline and half eucalyptus oil, twenty-eight miles were obtained per gallon, while when run on eucalyptus oil alone, as much as thirty-six miles per gallon of the fuel were obtained. He states that eucalyptus oil will mix well with gasoline, benzol and alcohol, and that it acts as a decarbonizing agent, maintaining the cylinders and pistons free from carbon. There are seventy different varieties of the eucalyptus tree in Australia. The oil yields range from 0.02 to 35 pounds per thousand pounds of the leaf treated. Distillation is a simple process, requiring no skilled labor. The main difficulty of manufacture on a large scale would be labor for gathering the leaves.—*The Chemical Age of London.*

Ethylene and Acetylene as Anaesthetics.—According to the *Klinische Wochenschrift*, 1923, page 113, both ethylene and acetylene have been used with considerable success as anaesthetics. The gases used are mixed with oxygen. Ethylene seems to have an advantage over ether in that it does not have the disagreeable after-effects of the latter. About 515 major operations have been performed with acetylene. A mixture of forty parts of acetylene and sixty parts of oxygen is used. A little oil of pine is added to hide the odor of acetylene.

Petroleum Oil from Rosin.—The Japanese chemists have been experimenting for quite a long time to produce petroleum synthetically. They have had quite some success in making petroleum from fish oil. Japan does not possess any extensive oil fields and so has to import its oil from this country and Europe. In the attempt to provide means for manufacturing petroleum from natural resources so as to fill the oil needs at home, an investigation was made to see if it were not possible to convert rosin into petroleum. The process has been reported a success. It consists in heating the rosin with acid earth, silicate of magnesia, under ordinary pressure. The oil, that is obtained by this treatment, varies in color from a pale green to a water-white. It has a carbon content of 88.6 per cent and yields on distillation, after purification with sulfuric acid, 50 per cent of naphthenes, 40 per cent of aromatic substances and 10 per cent of unsaturated compounds.—*Oil Paint and Drug Reporter.*

Rubber Celluloid Product.—Rubber and celluloid are combined to form a uniform mixture, known as celluloid rubber, according to a process which is described in the *India Rubber Journal.* The rubber is dissolved in benzine and the celluloid in amyl acetate and from these solutions there is obtained an emulsion by the aid of hexalin. When this emulsion dries, the constituents do not separate from one another. In this manner a quick-drying varnish is obtained, which sticks fast to metals and glass, but which is not very elastic. When about 5 per cent of celluloid is added to the rubber, the product remains soft and pliable. When 10 per cent of rubber is added to the celluloid, the latter is made flexible and less liable to break.

Destruction of Platinum Crucibles.—The destruction of platinum crucibles is always traced back to changes that take place in the chemical nature of the metal. This can be prevented by the avoidance of unnecessarily high temperatures when igniting precipitates, etc., in the crucibles. The compounds of platinum with carbon, silicon, boron, phosphoric acid, etc., are formed by the reduction of the salt which commences at a comparatively high temperature. The fact, that platinum at that temperature is pervious to hydrogen and hydrocarbons, makes the accomplishment of the reduction process much easier. Hence, in heating platinum crucibles in ovens, it is of prime importance to see that the atmosphere in the same does not possess a reducing character. For the same reason it is very bad to use acetylene for heating the crucibles as the life of the same is very greatly reduced by such practice. The ashing of organic substances should always be carried out at a temperature that is as low as possible. Ignition of the mass at the temperature of the flame of the blast lamp or in the oven should not take place until all the carbonaceous matter has been burnt off. Fused alkalies, alkali carbonates in the presence of sulfur, likewise cyanide of potassium attack the platinum crucibles very strongly at elevated temperatures. For further details see *Chemiker Zeitung*, 1923.

Waterproof Paper and Board.—A process has been patented for the manufacture of a water resistant paper or board, in which the paper is impregnated with a mixture of a wax soap, such as potassium or sodium creolate, with a binding medium such as glue or casein alkali and formaldehyde, and a filling substance such as barium sulfate, calcium carbonate or precipitated aluminum hydroxide. Colored fillers such as metallic compound of aniline colors may be used. After drying the surface is rubbed down and smoothed by calendering and the pores are closed in this manner. To produce a good insulator, the material is soaked in linseed oil, train oil, paraffine or other oil or fat before smoothing. A harder product is obtained by uniting two or more layers of paper with iron resinate or other laclike substance mixed with a little oil, and impregnating and finishing the product as above described.—*The World's Paper Trade Review.*

Patent Litigation, Its Causes and Results.—The causes of patent litigation most frequently lie in defects in the patent itself. It should define the invention clearly and not too broadly. This will be done if in the case of chemical and metallurgical inventions the patent chemist is given free hand in the preparation of the claim and the specification. Competent examiners in the patent office are most essential. Courts should have technical advisers. Two instances of hardships worked by decisions in patent litigation are given in some detail. In one case, a patent for a thing really novel, but too broadly claimed, was declared invalid. In another, a patent limited in its language but covering a novel and valuable discovery was at first declared invalid and not infringed, and on appeal was sustained but ruled by the majority of the court as not having been infringed.—*From a paper read before the Milwaukee meeting of the American Chemical Society.*

Tensile Properties of Cotton Yarn.—An investigation was carried out to determine the effect of important variables, such as moisture content, temperature, prolonged heating and lubrication on the tensile properties of cotton yarn. Two distinct varieties of cotton were studied, using an apparatus which permitted of close temperature and humidity control. It was found that up to about 12 per cent moisture, the tensile strength is increased, but beyond this even soaking in liquid water produces no further increase in strength. Increase in temperature from 20 to 140 degrees caused a decrease in tensile strength in the case of dry yarn of about 40 per cent. At any given temperature and humidity, the tensile value of practically a resultant of the two effects alone. Baking the yarn at 110 degrees centigrade for eight days caused only a slight decrease in the strength, but at 140 degrees centigrade the rate of decrease was rapid. Solvent extraction of the yarn thus removing the natural fats and waxes, caused an increase in the tensile strength of approximately 30 per cent, while the addition of castor oil to this extracted yarn reduced its tensile strength considerably, but not down to the value of the original yarn.—*Paper read before Milwaukee meeting of the American Chemical Society.*

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Our Psychic Investigation Advances

(Continued from page 115)

phenomena of any description whatever.

There remains the claim that this failure was due to bad psychic conditions. Dr. Vecchio catalogued two such—the long time occupied in the tying, and the size and character of the audience. If this sitting were an isolated one, these claims would both deserve the most serious attention. But the tying consumed more than an hour on both previous sittings, and only a little more than an hour and a half on this one. Nino was not visibly affected by the additional delay, which seemed intrinsically not of such vital importance as to make the difference between the results of the first two sittings and this one. As for the audience, much the same thing may be said. There were more than 20 people present, but there were only two or three more than on both previous occasions. There were some present who certainly made no contribution to the psychic atmosphere, and some who might have been charged with an unfavorable effect; but the same was true in practically the same measure on both evenings when we got results.

I write this part of my narrative before the sitting of the 21st, to expedite matters with the printer. For that sitting we plan tests which may well settle the thing beyond reasonable doubt. But regardless of this issue, or of the nature of our sub-committee's report, we plan to give Nino a few sittings in January, before a very carefully selected and carefully limited group, just to see what happens. At such sittings there will be no question regarding the suitability of anybody present. As to the time spent in tying, that is something else. If the tying is simply a bluff or a meaningless ceremony, we can get it over with in a few minutes; but if it is to be taken seriously as a check against the normal use of the medium's hands and arms and feet and teeth, it must obviously consume enough time to give a thoughtless partisan what he regards as ground for protest.

At this point I may well interpolate some general remarks based on the three sittings so far described. Neither Nino nor any of his controls is supposed to speak any English or to understand any. Nino himself, when undergoing Dr. Block's psycho-physical examination, could not take the simplest command without Dr. Vecchio's translation; Eusapia had no better control of our language. In the face of this, we got quite often a simple sentence in English from the cabinet—"Oh, yes"; "Wait five minutes"; and the like. Even more frequently there were indications that English was understood. Thus, when the whistle was blown for the first time, I expressed mild concern lest the police respond to the blast; and Palladino (speaking in her own tongue) rejoined that if they did, she would chase them off. Many mediums, to be sure, deliver messages in tongues that are strange, *to them;* but in such cases, the foreign language is always that which is native to the control of the moment. What we got from Nino was speech of which neither he nor his control was capable, and understanding of something that neither of them is supposed to understand—a very vital difference.

Even more suggestive was an incident of the second sitting. We were displaying restlessness over the extreme prolongation of the dead end of the seance, and in this connection Palladino informed us that it was 10.54. Inquiry showed that it was really 10.49. The slight error might have been forgiven and the item accepted as significant—had it not been for the fact that at 10.45, Mr. Lehmann had consulted his watch and announced the time, quite audibly.

Incidentally, there were at least three supporters of the medium present, and all of them would have ignored this very pertinent fact had they been permitted to do so. Aside from the obvious face value of the incident, this willingness seemed to cast grave doubts upon the accounts of the things that Nino does in informal sittings with his friends; there seems no reason to credit his circle with more accurate observation in our absence than in our presence. This is not at all extraneous to the question of Nino's mediumship, as at first glance it might appear to be; for with these very people, and them alone, originates the suggestion that Nino *is* a medium.

During the second sitting there occurred a violent blast on the trumpet. My secretary, in sewing the gloves on the medium,

(Continued on page 134)

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SCIENTIFIC AMERICAN

Our Psychic Investigation Advances

(*Continued from page 133*)

had been nearly asphyxiated by the garlic on his breath. The trumpet voice, otherwise inarticulate, carried the same message; three male sitters in its path and fairly close were fairly bowled over. It seems unnecessary to inquire whether this were celestial garlic on Palladino's breath. Nor is this matter a trivial one. The trumpet voice is supposed to be independent; and any evidence that it comes from the medium's throat is distinctly pertinent.

At one sitting we secretly introduced an Italian interpreter, who verified without reserve my impressions that in Dr. Vecchio's conversation with Palladino there was nothing which he failed to translate.

Only two or three times did the voice attempt anything evidential. Most of what was tried in this direction revolved about Dr. Carrington's previous association with the control; she expressed pleasure at meeting him again, remarked that she was now doing herself what the spirits used to do for her, etc. But there was nothing which Vecchio would not certainly know, and through him presumably Nino. During one sitting she remarked that Dr. Carrington was not present. It required more effort to assure one's self that Nino did not know this, than to get the same assurance with regard to any other of the control's statements.

Some acquaintance with psychic literature was indicated when the control asked (on the first evening) whether Dr. Prince were there, and promised that next time Katie King would visit us.

Individual experiences had with Nino by Dr. Prince, Dr. Carrington and myself had led to the rather definite suggestion that his trance was genuine, so that, even if the manifestations were demonstrated to be engineered through normal use of his hands and feet and mouth, there would be an interesting question as to whether they were in any sense subjectively psychic. As far as our award is concerned, we should not have to discuss this question, but as a matter of scientific interest we should want to discuss it. From the first, therefore, we made every effort to collect data regarding the precise character of the trance; and it was largely for this purpose that we enlisted Dr. Block's aid.

Dr. Block examined Nino with the utmost care before the first sitting. He found him of decidedly hysterical type, and extremely suggestible. With Nino's eyes fixed upon the point of Dr. Block's nose, a fountain pen was held in various positions in front of, beside and behind his face. His answer to the question whether he could see it or not was almost entirely a matter of suggestion; there was no difficulty at all in getting him to insist that he could see it when he obviously couldn't, or that he couldn't when he obviously could. Similarly, when pins were stuck into his calves, he failed to feel any pain when told that he didn't, and felt it when told that he did. Dr. Block was quite certain that he could himself hypnotize Nino with the utmost ease if only they had a common basis of language in which he might address him.

On the basis of these observations, Dr. Block's opinion after the first sitting was that Nino was in a self-hypnotic condition of submerged personality throughout the seance. This is another way of saying that his trance was genuine. It would mean, in simple terms, that Nino is thoroughly sold with the idea that when he is tied up, put in the cabinet, and left alone there in the dark, he goes into a trance—so sold that, given these conditions, he promptly hypnotizes himself into a trance state. He would carry under with him knowledge that, in the trance state, he becomes Palladino, with occasional lapses into the identity of his brother or his mother; also that he is expected to do what he can with the physical apparatus provided. These suggestions he would apply in his state of altered consciousness; and in addition, any request which Dr. Vecchio might make during the seance would be accepted as a further suggestion, and met if it were physically possible to meet it. Nino's convulsive action after being picked off the floor at the end of this first sitting was regarded as decidedly evidential of the genuineness of his trance.

At the end of the series, Dr. Block was inclined to modify his opinion. He was still convinced that Nino was in genuine self-hypnotic trance at the end of the seance, but pointed out that we had no evidence at all of a trance condition *during* the seance. Dr. Block applied the usual test of projecting the beam from a flashlight into the eye of the patient, holding the lids open for the purpose. This was done in the presence of Drs. Powers and Stearns, and after Dr. Vecchio had begun to bring Nino out of the trance. Dr. Block was more favorably disposed toward the result than the other physicians. Drs. Powers and Stearns objected that the eye-ball was not entirely motionless, as it should have been to make the test an unqualified success. Dr. Block urged that under the circumstances, this should not be expected; that it was sufficiently rigid to demonstrate the good faith of the trance. The pupil was conceded by all to have made no adjustment to the bright light thrown upon it.

Drs. Powers and Stearns agreed that the medium was a hysteric, and even mentioned dementia praecox. In testing out his physical development, Dr. Powers, a huge person built like Conan Doyle and certainly weighing well over 200 pounds, bore his entire weight upon the horizontally extended arms of the medium and was still unable to break them down or bend them appreciably. Nino's chest development is extreme, also. Houdini was very much impressed with his build, and said that Nino had a better physical equipment for escape tricks than he himself.

Nino often sits, sealed inside a cheesecloth bag, his hands and arms being fixed before he goes in, and the roping to the chair being done outside the bag. At Dr. Vecchio's suggestion, we had planned such a bag for our final sitting; and in this connection we had prepared several very effective tests. Nino never asserts himself in any way—indeed, in the event of his winning our $2500, Dr. Vecchio takes it for granted that he himself will get the money and keep it. Accordingly, when Dr. Vecchio telephoned that Nino refused to sit in the bag, I had difficulty in believing that the refusal came from Nino. But there it was, leaving us with five hours in which to revise our program.

It developed that Dr. Vecchio wanted to bring Nino's accustomed gloves and costume, and tie him himself. He wanted the chair fastened down again, and to save time he asked that we do this in advance. It was thus made possible, for the first time, to install electric contacts under the chair with the assurance that they would remain operative. We decided to proceed on this basis, plus scrupulous scrutiny of the bonds, before and after.

Dr. Vecchio's work was in some respects good, in others poor. Over the usual undergarment Nino wore a bathing jersey and long loose trousers of the same stretchable material. The jersey was low and loose in the neck; but being sleeveless, it forced the sewing of the gloves to the undershirt sleeves.

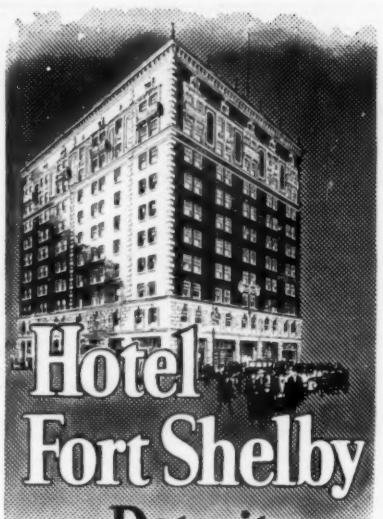
The gloves were canvas—easier to get out of than wool and more likely to retain their form while empty, but giving less freedom if they stayed in place. The arms were bound together at one point only, where the wrists overlapped; here a wire passed around six or eight times, and was supplemented by a strip of cloth. Both were tight, but left the arms as free as those of a pair of scissors with their single bearing point. On the other hand, the whole assembly, in the event of complete escape by both arms, would be less rigid while awaiting their return than one involving coat sleeves and a wider distribution of wire. On this rock Nino split.

Nino's ankles were now tightly strapped together and secured with a padlock—excellent as far as it went, but leaving him still to be fastened to the chair. In doing this, the ropes were used in excessively long pieces, which were passed and repassed about medium and chair, and chair and medium, with effective knots only at the very ends. Even without playing off of slack, there was considerable freedom of motion for the arms assembly and the chest.

I take it that Dr. Vecchio is quite honest in so underestimating the necessity for immobility of Nino's imprisoned arms, and of his chest and shoulders. I am not so sure that it was with good intent that he tried to get Dr. Prince and me to give a blanket endorsement of the tying. We both felt that Nino could get his hands free only by breaking something, but that he had an alarming degree of movement without getting them free. We insisted that we could endorse the tying only after seeing what it looked like at the end, and this Dr. Vecchio accepted with rather bad grace.

The seance was slower than usual, 36 minutes elapsing before the first raps. The interval between the raps and the active phase

(*Continued on page 138*)



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(*Continued from page 131*)

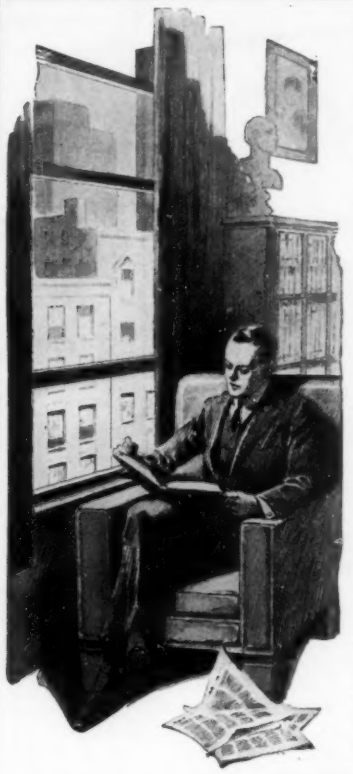
efficiently; drilling is done by electric drills; hauling is simplified and trips can be scheduled more definitely and haulage costs reduced; less timber is used; roof falls less readily because of speed of progress and, in longwall work, less working room is required; concentration of workings produces large tonnage in small areas, inspection and supervision being more effective because of the smaller area kept active; cost of track equipment and maintenance is reduced by having fewer rooms or if longwall is provided by having no rooms whatever; cost of drainage is reduced by the smaller active area; cost of ventilation is lowered for similar reasons; cost of plant construction per ton and maintenance is reduced by reason of the larger production per man; waste of coal is lessened by larger recovery; safety—the most important factor in mining—is increased.

In the New Kruskopf Method of Blasting, by which a 30 to 40 per cent saving in explosives is made and as much as 50 per cent more lump coal produced, a long pressure chamber is formed by the expansion of the gases after the detonation of the explosives. This result is attained by the use of a fine-grained rock dust for stemming. The dust is compressed by the explosion and closes the bore-hole so tight that a paper sack placed directly in front of the hole is not broken by the shot. This long pressure-chamber provides the most favorable shearing lines and consequently makes it possible to use a minimum of explosives.—*Explosives Engr.*, 1:7, pp. 181-84.

General

The Economics of Trans-Atlantic Liners of Various Lengths forms the subject of an analysis which leads to the conclusion that for the greatest return on investment today, the 600-foot ship is the logical choice, a vessel of this length giving about seven per cent per annum return on investment. If a return on investment of about 3 per cent would be sufficient, an owner would be justified in designing, building and operating a vessel of 700-foot length. The construction and operation of any vessel having a length exceeding this cannot be justified from an American private owner's point of view under existing conditions. There are very few trips in the year when the 900- or 1000-foot ship will approach capacity in passenger carrying performances, and during the rest of the year these vessels will not carry any more passengers than, say, the 600 or 700-footers. It may, therefore, be said that world conditions will have to improve very materially before the 1000-footer is an economic probability for either a European or American company, although less so for the European.—*Marine Eng. and Shipping Age*, 28:13, pp. 759-63.

The All-metal Hull for Flying Boats is anticipated as a standard future design, according to a writer in *Metal Industry*. The problem of duralumin aircraft construction had been approached in various ways by different European and American constructors with more or less success. It seemed to the engineers after studying the situation that the mistake most generally made was that of using too thin metal, yet the machines designed with this thin metal were always comparatively heavy. Upon further analyzing the situation, it was decided that the reason for this was the fact that the skin or plating was used for covering only and in most cases was not employed as a strength member. It was determined in the aeromarine hull construction to use a thick enough skin so that it would not be easily damaged and to make this skin take the loads imposed upon the structure, the interior bracing or frames and longitudinals being used as stiffening members only to carry the loads to the skin. Accordingly in the hull proper it was decided not to use any metal thinner than .040. To the surprise of all concerned, it was discovered that the assembled figures indicated a structural weight lighter by 100 pounds than the weight of a similar wooden hull. The problem of water tightness was overcome by the use of canton flannel and asphaltum interposed between the thicknesses of metal. There seems to be little question but that this alloy flying boat hull construction is here to stay and it is only a matter of time before all aircraft will be built of metal as is the railroad equipment of today and that this metal aircraft will be as far superior to the old type wooden planes as the new steel Pullman coach is superior to the old wooden passenger car.—*The Metal Ind.*, 21:12, pp. 471-73.



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Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

A Low-Priced Loud-Speaker—$10 list—has lately been placed on the market by the manufacturer of well-known head 'phones. This loud-speaker is of neat construction and is said to have a clear, resonant, mellow and realistic tone. Requiring little more power than the usual head set, this loud-speaker can be used with the usual receiving set and two-stage amplifier.

Long-Distance Reception with Crystal Detector is reported by Frank Heinfling, radio officer of the steamship "Californian." With a galena crystal detector, Mr. Heinfling intercepted the NAA station at distances of from 3500 to 4100 miles. Confirmation of these results has been had from the Bureau of Navigation. With a Telefunken type E-266 single-bulb set, Mr. Heinfling copied the German station POZ at a distance of 5500 miles and also received music broadcasted from WOC of Davenport, Ia., in the Pacific some 2500 miles away. This receiving set makes use of an arrangement which does away with the filament and "B" batteries.

Many So-Called "Bootleg" tubes are now appearing on the market and are being offered at lower prices than the standard tubes. Furthermore, in general appearance these tubes resemble quite closely the standard tubes, and are said to have the same operating characteristics. It would seem that the independent tube manufacturers, despite claims to the contrary, could not produce tubes of the thoriated filament type, with extremely low current consumption characteristics, because of the inherent difficulty of making the special filament. Reports from users of independent tubes are generally to the effect that these tubes are not as satisfactory as the standard tubes.

The Myers Tubes—those characteristic tubular vacuum tubes with red and black ends, fitting into clips after the fashion of the usual cartridge fuse—are now being made in Montreal, Canada, and may be obtained from some dealers or by mail. These tubes have long been known for their high efficiency, especially for audio-frequency amplification and radio-frequency work. At present the Myers tubes are being made in two types: the dry battery tube, 2½ volts and one-quarter ampere, and the universal tube which operates on either three dry cells or storage battery. The tubes are now coated with silver, instead of being furnished with clear glass as in the past.

Run-Down "B" Batteries are often the cause of unsatisfactory results with a receiving set. The best manner to test out "B" batteries is by means of a voltmeter with a reading of 25 volts for testing out 22½-volt units, and a reading up to 50 volts for testing out 45-volt units. Electrical instrument manufacturers have not been slow to realize the need of inexpensive voltmeters for this purpose, with the result that such meters may now be purchased for as little as $2.50. One manufacturer has developed a special meter which may be placed in the usual peep-hole of the radio panel, and which serves to give the "B" battery voltage or the current consumption of the filaments.

Capacity Shields have been widely used in the past for eliminating or reducing the troublesome capacity effect in regenerative circuits. It is now claimed that capacity shields should not be employed, in that they decrease signal strength and broaden the tuning. Instead, the builder of a radio set should see that all instruments in the tuning assembly, such as coils, condensers, variometers, variocouplers and so on have the side next the panel and the shaft side connected with the grounded side of the grid battery circuit. Audio-frequency transformer cores sometimes need to be grounded. Manufacturers of regenerative sets generally do away with shields by placing the inductance units some distance away from the panel, and using insulator couplings between the dials and the instruments.

Directed Radio Waves for broadcasting are predicted by Marconi himself. As the result of numerous experiments with directed radio waves, Marconi has come to the conclusion that this method of communication is not only highly practicable, but that it must bring about far greater efficiency. In collaboration with C. S. Franklin, the great inventor recently communicated over a distance of 2250 nautical miles with considerably less expenditure of electrical energy than is generally used. Marconi has been led to believe through his recent successes in directed radio, that owners of crystal sets in the United States will soon be enabled to receive messages broadcast from London, because all the radio energy will be sent out in one direction thus intensifying the signals in receivers lying within that beam.

Short-Wave Relay Set.—Again the General Electric Company has scored a marked advance in radio broadcasting, this time in the form of a short-wave relay set which may be transported to the scene of church services, banquets, dramatic performances, and so on. Instead of depending on a telephone or telegraph line between the scene of activities and the transmitter of the broadcasting station, the present set transmits the radio program to the broadcasting station, where it is picked up, amplified, and turned over to the usual transmitter to be broadcasted to radio listeners. The short-wave relay set broadcasts on such a low wave length that it cannot be intercepted with the usual receiving set. It is said that this rebroadcasting arrangement does not affect the quality of speech or music, and that listeners have been unable to detect the use of the short-wave relay set in place of the usual wire link.

A New Type of "B" Battery developed by the engineers of the Burgess Battery Company marks a distinct innovation in such batteries. This battery has dimensions and weight which coincide exactly with the standard No. 6 dry cell commonly used for filament current. The new battery is a 22½ volt "B" battery. It is 6 inches high, with a base 2½ inches square. The terminal connections are brass binding posts at the top. By an ingenious method of construction the fifteen cells, individually insulated, are placed in a vertical position in two inner compartments. These compartments are arranged one above the other, and the whole is enclosed in a non-metallic, non-inductive, waterproof container. The electrical capacity of the battery at two milli-amperes is about 500 hours, which places it in the group of so-called medium-sized "B" batteries.

The Importance of Good Insulation is not fully realized, even at this late date. Manufacturers of inferior apparatus and sets still make use of wood as a support for instruments and terminals. They even go so far as to give a wood panel or base a coating of nice black paint, so as to convey the optical illusion of good insulation. However, radio-frequency currents are not deceived by black paint and, if anything, such paint causes greater leakage than ever. Receiving sets should be insulated with the greatest care. Only bakelite or similar material, as well as hard rubber, should be used for panels and for terminal blocks or strips. The antenna circuit, too, should be carefully insulated. It is surprising how elusive radio frequency currents can be. Even insulated wire will not keep radio current in place, so that glass, porcelain or composition insulators should be freely employed. Otherwise, a marked decrease in efficiency is found to take place, especially in damp weather.

The Neutrodyne Receiver is steadily growing in popularity, because of its selectivity, its far-reaching scope, and its utmost simplicity. The usual neutrodyne set has two stages of radio-frequency, a detector, and one or two stages of audio-frequency amplification, making a total of four or five tubes. Only three controls are used, two of which do most of the work while the third clarifies and strengthens the signals. In the correctly constructed neutrodyne receiver, there is no distracting whistle or distortion. The remarkable feature of the neutrodyne receiver is that the same stations will come in day after day with the same adjustments of the three dials, so that the user merely has to chart the various stations according to the readings of the three dials, and from that

time on the stations can be tuned in by simply setting the dials to the chart numbers. As for selectivity, the neutrodyne, operating in a congested radio section such as New York City, readily tunes out nearby stations to pick up long-distance stations. When it comes to distance, a properly constructed neutrodyne receiver in New York City will pick up the Pacific Coast broadcasting stations at night as a fairly regular performance.

Furniture Radio, so called, is becoming more and more popular. Virtually all the leading radio manufacturers are now turning out radio sets made in the form of attractive furniture. Thus the self-contained and attractive furniture radio set is finding its way into the living room of the finest home, instead of being relegated to some odd corner as in the past, when it required mussy storage battery, a mass of "B" batteries, and a maze of unsightly wires. The furniture radio move is an excellent one and will no doubt do more to give radio a definite place in the home than anything else. However, there is the ever-present danger that furniture radios may become more furniture and less radio. That is to say, there are already ample signs that the radio end of some furniture radio sets is not what it should be. Too much attention is paid to making the set look attractive, and too little to radio details. Furthermore, the wish is often expressed by the public that the manufacturers of the highest grade and most efficient radio sets put their highest type radio sets into furniture radio form. After all, it is the radio set proper, and not the beautiful Jacobean period cabinet, that brings real pleasure into the home.

Standard Frequency Tests.—The Bureau of Standards is transmitting special signals of standard frequency about twice a month. The signals can be received and made use of with the average receiving set in the general territory east of the Mississippi. These special signals are of use to testing laboratories, transmitting station operators and others in checking wave meters and adjusting transmitting and receiving apparatus. The accuracy of these special signals is better than three-tenths of 1 per cent. All transmissions are by unmodulated continuous-wave telegraphy. A complete frequency transmission includes a general call, a standard frequency signal, and announcements. The general call is given at the beginning of the eight-minute period and continues for about two minutes. This includes very long dashes with the call letters WWV intervening. The announcements are on the same frequency as the standard frequency signal just transmitted, and contain a statement of the measured frequency. An announcement of the next frequency to be transmitted is then given. There is then a four-minute interval while the transmitting set is adjusted for the next frequency. The schedule indicates that signals will be transmitted from 11 P. M. until 12:32 A. M., Eastern Standard Time, on January 21st, February 5th and 20th.

Interference is on the increase, especially in the New England and Middle Atlantic States. Indeed, evening after evening radio programs are seriously marred by radio telegraphic interference. It appears that the greatest interference comes from certain ship and shore and Navy radio telegraph stations employing the 450-meter wave length, which falls in the middle of the broadcasting wave length range. The Radio Club of America, the pioneer radio amateur organization of the world, has taken up this matter and is exerting every effort to put an end to the present very unsatisfactory state of affairs. Two operating companies have been using the 450-meter wave length and causing serious interference with radio programs. One company has indicated its willingness to abandon the 450-meter wave length, provided its competitor do likewise. Another source of interference is from the shore stations operated by the Navy. Steps are now under way, with a view to having the commercial stations as well as the Naval stations abandon the widely-tuned damped radio transmitters in favor of the sharply-tuned continuous-wave transmitters. Another source of interference is the re-radiation of regenerative sets in the hands of inexperienced or careless operators. In truth, this interference is the most serious of all, for one "ham" operator can, with a regenerative set, spoil the programs for other receivers scattered over a wide area. Gasoline engines cause considerable interference, because of the spark ignition which sets up radio waves. Arc lighting is also a prolific source of interference.

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Eveready "Three"
4½ volts, three distinct uses. Length, 4 in.; width, 1⅝ in.; height, 3 in.; weight, 14 oz.
At all reliable radio dealers.

This "C" Battery is a Wonder Worker

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You already have an "A" Battery for the filament and a "B" Battery for the plate. A "C" Battery is connected to the third element of your vacuum tube, the grid, affording a control that is marvelous in action on audio frequency amplifiers.

As a "C" Battery the Eveready "Three" prevents distortion and excessive flow of current from the "B" Battery, lengthening its life. It is a wonder worker that saves its small cost many times over. Connect it in your audio frequency amplifier and note the difference. Full directions on the label and in "How to Get the Most Out of Your 'B' Battery," a booklet on "B" and "C" Batteries, sent free on request.

This triple-use battery can also be used as an "A" Battery in portable sets. Light and full of pep. Its third use is as a "B" Battery booster.

Use the Eveready "Three"—a tested product of the world's leading electro-chemical battery laboratory. It serves more radio uses and effects more economies than any radio battery heretofore developed.

If you have any battery problem, Radio Battery Information Headquarters will solve it for you. Write G. C. Furness, Manager, Radio Division, National Carbon Company, Inc., 216-218 Orton Street, Long Island City, New York.

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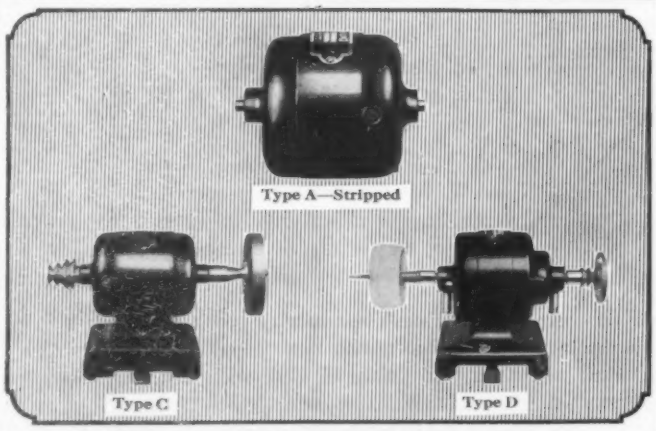

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We invite your inquiries—solicit difficult, hard-to-meet specifications. If you believe a specialized knowledge of fractional h. p. motors and their applications would be of assistance to you, just write our Advisory Department. This service is free to all who request it.

WISCONSIN ELECTRIC COMPANY
4868 Sixteenth Street Racine, Wisconsin

DUMORE *Universal* MOTORS

Our Psychic Investigation Advances

(*Continued from page 134*)

was also longer—20 minutes. The active phase lasted 13 minutes, and was the most brilliant we had had. I describe only the items not previously experienced. The map of the third sitting applies equally to this one.

There was a great deal of what Dr. Vecchio described as blowing upon the curtains, and blowing of them out into a bulge. Most of us took this to be rather stroking and pushing with the trumpet. It was very violent; ultimately the table was upset in a spasm of this sort.

After prolonged ringing, one of the bells was pitched out of the cabinet. Palladino specifically named Dr. Vecchio to pick it up and thrust it inside the curtains; as it was taken from his hand, this was gently slapped, giving him the same impressions that he would have got from a flesh-and-blood contact. He asked that my hand be dealt with similarly, and Eusapia promised; but under continued reminders she failed to make good.

For the first time we got hand-clapping from within the cabinet; for the first time (see below) there was reason to suppose that both Nino's hands were free.

Tailing off was much as in previous sittings. A violent outbreak was followed by peace, with Palladino speaking more frequently than before. She began to promise us apports, and all sorts of wonderful things; I whispered to Mr. Lescarboura that this orgy of promises was a sure sign nothing more would happen. Dr. Vecchio seemed to know it, too; abandoning his close watch of the cabinet, he swung about in his chair and engaged in animated conversation with an Italian visitor behind him. Ultimately he began to ask Eusapia if we might terminate the sitting; and after the ringing-off process had run for 37 minutes, he got her affirmative answer.

Now at all seances there is delay at the start, to get the forces going; and at the end, to get them toned down so that the control may safely leave. But with a high-grade medium I have never had these intervals run into such major fractions of an hour as with Nino, and never seen such complete suspension of activity. I think it fair to say that this strongly suggests the long and difficult processes of escape from the bonds and return thereto. Particularly objectionable is the wait of from 40 minutes to an hour, after everybody realizes that, speaking practically, the seance is over.

Entering the cabinet to examine the bonds, we found wires and ropes substantially undisturbed, with one important exception. Loops that had passed about the chest and upper arms were now down at waist and elbow, respectively, where they would hamper movement neither of the parts above these joints, nor of those below. Initially they were not loose enough to have fallen down, unless greatly stretched by violent straining. That this could have been done was indicated experimentally; a six-inch piece of the rope was lengthened half an inch by one vigorous pull of the hands. This rope, incidentally, was one of the things brought in by Dr. Vecchio.

When we came to the medium's actual garments, one sleeve of his undershirt was spiralled about his arms, like a sock that had been twisted in being pulled on, making two complete turns between wrist and shoulder. This gave the strongest possible suggestion that he had been out and in again—I know no other way in which it could have been so twisted, in fact. The other sleeve showed about three-quarters of a full turn. The body of the shirt was entirely unbuttoned; the buttonholes showed indications of having been violently wrenched, rather than opened naturally; and at least one button had been yanked off, to be found on the floor. The right side of the shirt was substantially in its natural place over the medium's chest; regarding the left wing little could be seen, with the jersey in position, other than that it was seriously displaced.

A move to investigate this further afforded the first visible indication of our interest in the shirt. It was met, without the slightest warning or premonitory symptom, by what was plainly meant to be taken for a violent epileptic fit. Dr. Stearns stated categorically that the attack was not epileptic, at least two essential symptoms being absent and at least one irreconcilable one present. It was purely hysterical; consciously or subconsciously, the fact had been noted that examination was about to trespass upon critical

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ground—and the means available were used to prevent this.

Prevention, however, was only temporary. While Dr. Vecchio and his secretary calmed Nino we took the liberty of eavesdropping. We were rewarded by noting that part of the "calming" process consisted in putting his garments in order. We learned that a substantial fraction of the left side of his shirt was reversed into a sort of balloon effect and jammed down the left sleeve, along with his arm. We noted that the safety pin which had originally joined the jersey and the undershirt, in the middle of his back, having lost its grip on the jersey but kept hold of the shirt was salvaged from the neighborhood of his elbow. We said nothing about all this—and neither did the doctor. It is not the first time he has connived in the attempted suppression of evidence unfavorable to his medium.

The canvas gloves were wet, on the outside, where the perspiration with which the medium was liberally anointed could not have penetrated. We also found teeth marks on the canvas. The bells, which alone of all the apparatus were well suited to the reception and preservation of the finger print, showed a liberal sprinkling of these—as apparently they always do when it is believed that the medium has been able to free a hand.

At the beginning, the second chair with the apparatus was 21 inches from the medium's knee. At the end, it had been moved to within 10 inches. The tell-tale light in the next room had never flickered, proving that at no time had Nino taken his weight out of the chair. We have verified experimentally that, tied as he was at the end but with both arms free, he could have got possession of the other chair without contradicting the evidence of the lamp. We have verified that, under the same conditions, he could do everything that was done. He would have to exercise a little ingenuity in the manipulation of other objects with the trumpet: but that is all. In order for the impossibility of moving the medium's chair about the cabinet to be significant, the two chairs would have to be separated by a full yard, at the very most.

More generally, everything that was done at any of the four sittings, we can do, given the degree of freedom which the present narrative suggests the medium had in each instance. The members of the committee and their outside consultants are unanimous in feeling, not alone that no evidence is presented of the genuineness of the manifestations, but equally that good evidence is presented for regarding them as having been produced by normal use of the medium's anatomical apparatus.

As to Nino's trance, no such complete agreement exists. Dr. Block is strongly impressed with the fact that, whatever we know about his condition at the end, we have no evidence at all regarding his condition during the sitting. He feels that for one in actual trance, clean-cut faculties of association would be impossible—in this respect the person in trance ought to be like the dreamer, who associates familiar and unfamiliar things in the wildest and most absurd ways, without ever realizing the absurdity until he wakes. The derangement of the associative faculties here implied, which Dr. Block thinks ought to exist in

(*Continued on page 143*)

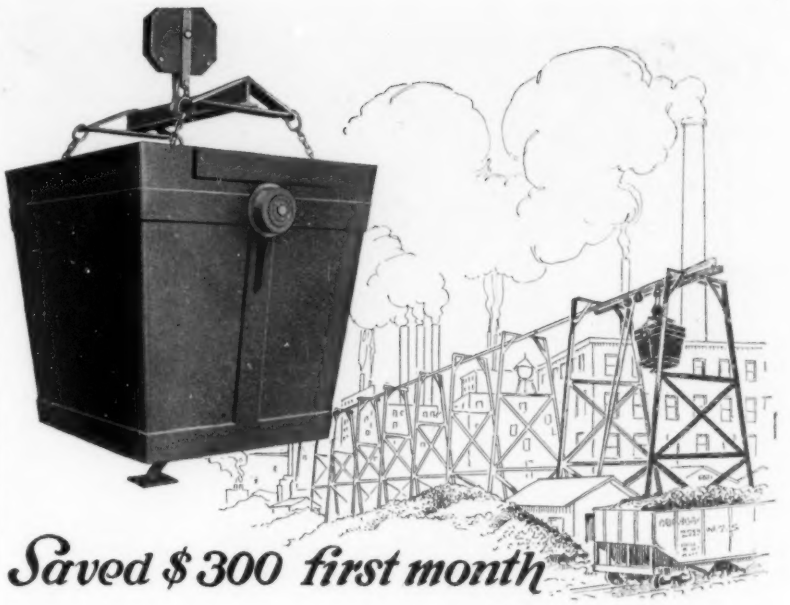
Remolding Our Civic Clay

(*Continued from page 90*)

each part of each property, heights of the buildings on it, their front yard and setbacks, widths of side yards; number of families in each building; home occupations; street widths, grades, and pavements; and trees. The nature of this data, and the immense amount of time and thought expended on it go to show that city planning has indeed become a profession and that everything under the sun that pertains to the work is critically analyzed. Decisions are not left to "I guess." Instead, they follow directly from the study of the premises. They are like solving for x—there is one answer and you get it.

From the 400 little maps a map of the whole city was drawn on which the existing use of each building was classified by color. This map showed at a glance the extent to which zoning, without any directed efforts, already existed. A similar map showed in a corresponding manner the classification of buildings according to heights, setbacks, yards, lot widths and lot depths.

It would appear that in doing all this detailed work the city planners were earning their forty thousand dollars. These maps



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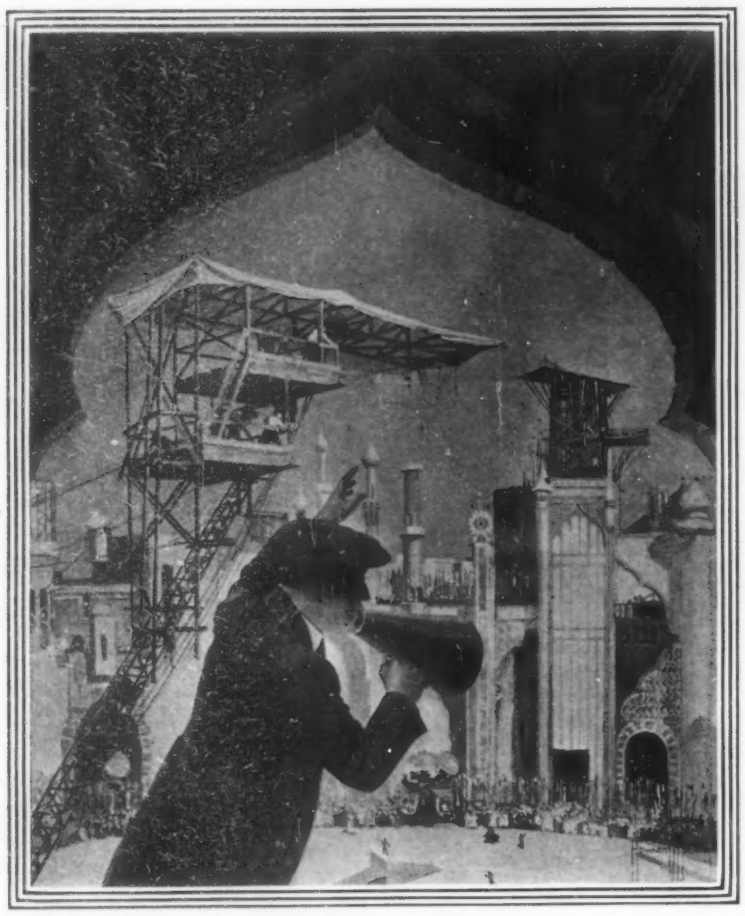

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Why certainly, wherever there is an important development in any of America's industries or enterprises, the Scientific American sends its reporters to gather the story on the spot.

In the case pictured above, Douglas Fairbanks has solved the problem of camera mobility with the traveling platforms and crane-like elevations—a problem that has long puzzled the engineers and construction experts of this industry. As such, it is interesting to the Scientific American reader.

Steel men and construction experts are writing the pages of progress in their industry; engineers are building greater projects, inventors perfecting their ideas; aviators and shipping men are continually hanging up new distance records; the psychics and psychologists are deep at work in their fields; explorers are opening the tombs of antiquity and roaming uncharted paths. And the Scientific American is a companion to all these works, a reporter of every development of practical importance.

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and the zoning ordinance that followed from them had to be based on a scientific study of conditions, land values, methods of construction, local fashions in building and the building code in order to make up a common-sense protection of property and give minimum hardship to individuals.

The zoning maps, now in tentative form, indicated each building which was contrary to the zoning ordinance for the district in which it found itself located, by special colors and symbols, so that they stood out. The districts were then readjusted so as to reduce to a minimum the instances of nonconforming buildings. The function of the city planner working on an existing city is not to make a perfect plan, for that he seldom can do, but to make one that comes only as nearly so as is reasonable, considering that changes cost money.

The Planning Board of the City of Springfield next held conferences and went over every detail of the ordinance and map. They further made trips into the city to study the matter on the spot. They wished to assure themselves that no consideration had been overlooked. The people of the city studied the ordinance and maps and discussed them with the Board. Several months were thus given to their consideration, for the Board wished to be sure it was right before it went ahead. The care given to the work and the time allowed for free discussion were an assurance that the city had looked before leaping.

Then the Board adopted the ordinance, presented it to the city council informally for revision, then formally after revision. It was printed and set before the public 30 days and finally passed and became a city ordinance.

But zoning was not by any means the only work done for Springfield. Fully as long and painstaking studies were made of the city traffic. Maps were made and reports compiled. Again, lengthy studies were made on the subject of railroad stations and track relocation; also on the matter of trying to provide an adequate public school athletic field.

All of this work was done in a careful, thorough and often plodding manner in order to assure a scientific job. The city planner did not have to begin exactly at the bottom of the pile, however, for he brought to Springfield the invaluable experience he gained on doing many similar jobs for other communities. Instead of attempting to settle its own problems Springfield called in expert aid from outside. And, despite the fees the city planners thus earned, Springfield without a doubt saved money.

One Law versus Forty-Eight

(Continued from page 96)

tion and several of party control. His department is thoroughly on its toes in every respect; but the code under which it has to operate is a fearful and wonderful mess. There are two separate organic Acts, the "Traffic Act" and the "Motor Vehicle Act." Presumably because the former is older and was originally self-sufficient, lots of things are found in it which one would expect to find in the other; and, for some reason less clear, the reverse is also true. There is absolutely no way of guessing in which of these two Acts a desired regulation will be found.

This would be bad enough, but it is made worse. Both Acts are printed in the one pamphlet, *each followed by its own index*. The index to the Traffic Act falls at the physical end of the book; and it is sufficiently large and imposing to pass as complete. Only after having riffled the pages and discovered by accident that there is another index in the middle of the book, at what turns out to be the end of the Motor Vehicle Act, does one learn the double-barrelled character of New Jersey's motor code, and suspect that the single index at the rear of the book doesn't cover the entire ground. Until one makes this discovery, it is obvious that important provisions of the law are more impossible of location than if the book had no index at all—they are, apparently, quite missing. Incidentally, the two Acts taken as a whole are miserably codified, overlapping repeatedly, so that no indexer in the world could make their contents easily accessible. When one has learned the peculiarities of this booklet, one feels obliged, even after finding an item in one Act, to scan the index to the other for further enactments on the same subject.

In skilful codification of the law plus skilful indexing, the Missouri pamphlet has a clear lead over all the others. Vermont and Massachusetts show admirable indexing

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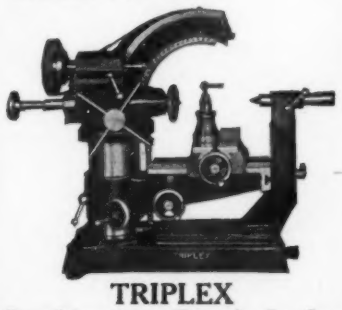

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of a poorly codified mass of law. The New Jersey indices, for that matter, taken individually, deserve the same compliment.

The Michigan pamphlet deserves a special paragraph of commendation—mingled with some regret that the chap who did such a good job didn't incorporate a few obvious betterments. The existing motor code of this state consists of a large number of sections from the codified general laws of 1915, plus various amendments, plus a quantity of separate and additional acts passed at various dates since 1915. The booklet is compiled in the office of the Secretary of State, and instead of merely stringing the additional laws along chronologically, the compiler has endeavored to put them in a logical order. Barring the fact that the logical place for some of them is somewhere in the middle of the matter abstracted from the 1915 code, while he has placed them all after this material, he has done a good job; and he has supplied a very fine index that makes the whole content of the code extremely accessible. Where the sections of the 1915 code have been amended, note is made of this with reference to the year and number of the amending act; which is admirable, except that it leaves one with the suspicion that the amendment has *not* been incorporated into the text, and with no way of disproving this save by searching the latter half of the booklet and noting that none of the cited amending acts appears there. But where this pamphleteer has fairly created a standard for all other codifiers of motor law to follow is in the insertion, after various sections of the law, of citations to cases and official opinions bearing upon the preceding text. Most of these are Michigan decisions, but a few come from outside the state. Some are so complicated that the pamphlet man has not attempted to summarize their import, referring to them merely by name and date; most of them are sufficiently simple so that he can indicate what bearing they have upon the text of the law. The entire booklet contains 94 such citations, and its value is increased by them, beyond all estimate.

A number of the motor-code pamphlets carry, on the first page or two, a display of the more vital features of the code, in quick and snappy language of some sort. This is probably a good feature, though it might be argued that it diverts attention from the provisions of the law—necessarily numerous—which are not thus displayed.

Well: let us suppose that through some millennial chance, all our States should codify their motor laws properly, publish them in attractive pamphlets skilfully indexed, and placard them after both the Connecticut and the Pennsylvania schemes. Effort to aid the motorist could go no further; yet it would not have gone far enough. An American driver of years' experience can, after a short stay in England, force himself to drive on the left of the road; but unless he stays in Great Britain for a long time, he will have narrow escapes, suffer horrible scares especially at night when he sees lights hurtling toward him on his "wrong" side, and he will be responsible for scaring a lot of eminently correct British drivers out of their seven senses—all without becoming a finished left-hand driver. If he stayed long enough to become this, he would have to go through the whole business again, on returning to a right-handed country.

Between no two of our States is there any such glaring single point of motoring divergence as there is between England and the rest of the world in the choosing of the side to drive on. But even so and just so, in the smaller things that are differently regulated in our different States and municipalities, one cannot pass instantaneously from one set of reflexes to another. Yet instantaneously one crosses State lines and city boundaries, and is called upon for this shift. It can't be done without some fumbling and some reversion to the more familiar customs; and, of course, the greater the emergency the more probable this reversion. All the printed matter and signboards in the world won't prevent an old and ingrained habit from asserting itself. And when one carries across the line the habits that should be left behind, one becomes at best a source of annoyance, and at worst an active element of danger.

The root of the difficulty, then, lies not in the ignorance of the motorist, not in the difficulty of informing him, but entirely in the fact that, within the territory covered by the average motorist, there exists a plurality of motor codes. If, confining our attention to this angle, we ask why such plurality should exist, there is but one answer—there is no reason why it should. There is, of course, a reason why it *does* exist

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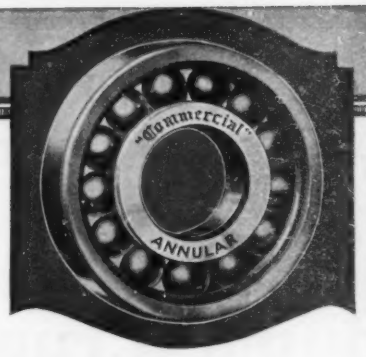

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—48 different legislatures, in 48 different States, have been passing traffic laws, each with no reference to what the others were doing. Evidently this must lead to approximately 48 different ways of doing the same thing. The conflict is not deliberate, it has arisen automatically.

Unfortunately, it can't be eliminated automatically. Elimination must be a matter of deliberate and considered action. And unfortunately, elimination cannot proceed merely by persuading the individual State legislatures to stop enacting new traffic laws on their own motions and their own responsibilities and their own judgments as to what is proper. This would be a pretty large order, of itself; but to remedy the situation that now exists, it would be necessary to reopen a lot of closed business and induce the individual legislatures to repeal or seriously modify much old legislation. This, obviously, is an even larger order. One might hesitate to try to fill it, were it not so very clear that such failure will bring us to more grief than we could possibly get out of an attack upon the problem. How, then, is such attack to be made?

Of course no club can be held over any State, nor anything that suggests a club. Legislators are notoriously sensitive about their prerogatives; and it might seem that, with all the matured deliberation and all the engineering authority in the world, the prospects were pretty remote of getting a large number of independent legislative bodies, all serving distinctly local interests and all hardened in local viewpoints, to agree upon the same measures. Experience contradicts this pessimistic attitude.

The Motor Vehicle Commissioners of 12 States—New England, the Middle States, and Ohio—got together not so long ago; and with the expert advice of the Automotive Society and the Illuminating Engineers, they worked out a standard for headlights that was designed to combine maximum illumination with freedom from glare. Coupled with this was the utterly revolutionary proposal that the States should set up official testing bodies, examine all headlight assemblies, and publish a list of the tradenames and the manufacturers of all those which complied with the standard set up by the conference. Finally, a law was to be asked from each State legislature, adopting this standard as that of the State, and barring all unlisted headlights.

Now, here is everything that a narrow-minded and suspicious person might be expected to object to, and everything that a legislator might fear, even if he didn't himself object to it. There was the strong suggestion of domination from without the State; there was the element of submission to expert advice, so often the anathema of politicians; there was the placing of a State-wide monopoly over an essential article in the hands of a limited number of manufacturers; there was what might be construed as advertisement of this monopoly and these manufacturers at State expense. Yet so obvious were the advantages of the new standard itself, so enormous the advantages of a uniform headlight law for 12 States forming a solid geographical block, so complete the authority of the technical bodies whose engineering advice had been had, that in no instance has there been difficulty in getting the legislation through. Any motorist in any of these 12 States may now drive freely through the other eleven, without a thought for the question—always before a veritable Chinese puzzle—whether his headlights are legal. In precisely the same way, through amicable conference between the responsible heads of the State traffic and highway bodies, plus such engineering organizations as may be able to aid in each instance, it ought to be possible to get uniform legislation on any other points to replace the present hodge-podge.

One danger must be avoided. What we have outlined involves asking many States to change their laws in many details. We dare not do this hastily. If, after our request has been met by the States, it turns out that the uniform law thus obtained is not workable, or is not the best way of gaining the end at which it is directed, or perhaps is not even a proper way of doing this, it is going to be far more difficult to get agreement a second time from the legislatures that have been thus victimized once. A definite, authoritative, orderly procedure needs to be set up for deciding just what provisions a standardized motor-vehicle law should contain, and for resolving the very ticklish question of what values should be assigned to speed limits and other things that require numerical determination. Only with such procedure is it thinkable that State legislatures would be sufficiently impressed to enact identical standardized provisions, unspoiled by spontaneous amendment.

It would not be so simple in all directions as it was in the matter of lighting. What to do at a railroad crossing, how fast it is safe to drive at a given point, how best to dodge the patrons of the street car—these are questions on which the layman feels that he has an opinion which he can match with the pronouncement of the expert much better than he could in any such recondite field as that of headlight standards. Agreement on many of these items could be reached only after prolonged general discussion, with an attempt to educate those whose views appear destined to hold a minority position. Assurance that the best solution had been attained would in many instances require a comparable process.

But the thing ought to be feasible. It ought to be possible to block out a standardized traffic act, covering all the ground that such an act ought to cover—defining, in fact, this ground. In many respects, such as the fixing of licensing fees, it could be only a blank form, to be filled in in detail by each state. In many other respects its whole value would consist in the expectation that it would be adopted, without changing a line or a figure, by every state. Such adoption could very well come piece-meal, by gradual amendment of existing codes; or where it turned out possible to convince any state legislature that the entire motor code of the state was in need of revision and recodification, the standard code could be presented, with the hope that it would be adopted without amendment. If this were not realized, at least it could be accepted in its substantial framework, greatly simplifying the subsequent work of uniform codification and of securing further uniformity of the text.

Our articles of January and of this month have been destructive in the general trend of their criticism—they have been devoted to showing how hopeless the present conditions are, and how imperative it is that remedy take the form of standardized motor legislation. Future articles will take up the constructive side. We shall display and compare specific provisions of specific state codes, suggesting the best. We shall inquire what ought to be included in the law and what omitted. We shall seek suggestions in the code of each state for laws which could advantageously be applied in all.

And we shall hope most fervently that we shall not have the discussion all to ourselves. We encourage opinions and arguments from our readers. Write now and tell us what you think ought to go into a uniform traffic law; write later on and criticize the specific suggestions which appear. We hope to make the SCIENTIFIC AMERICAN an open forum through which this important matter may be discussed, and much of the preliminary work effected of clearing the ground for uniform motor legislation throughout the country.

The Romance of the Lock

(*Continued from page 79*)

they might contain. He did not want to injure the safes, for there was a chance of acquittal. Accordingly the makers of the safes and many other experts, employed by other safe manufacturers, were summoned and did their best. They tried this and that and the other, but they could not "feel out" the combinations.

Biancolo read about these unhappy proceedings in the newspapers. One morning he strode into the office of the district attorney, pulled off his overcoat and announced that he'd like to see what he could do with the safes. He bent down over the first one and went to work. He did not sensitize his fingers, to be sure. Indeed, he did not trouble to wash off the grease and grime of the workshop. Instead he began slowly rotating the dial back and forth, feeling carefully, with an ear pressed against the safe door, listening with great intentness. From time to time he stopped, scratched his head and seemed to be calculating. Five minutes he worked away; ten minutes; fifteen.

The experts stood about in a grinning and contemptuous group. One or two were guilty of invidious remarks and condescending laughter. Biancolo paid no heed. For five minutes more he went on turning the dial delicately in the tips of his fingers. Suddenly he straightened up, twisted the handle of the safe and swung the door open.

The gentlemen who had nobly failed to do this very feat grew shame-faced or open-mouthed. They waited to see this wonderful fellow open the second safe in about five minutes and then departed without comment.

Later on, I talked the business over with

the safe opener and found that he was in the habit of doing just this trick and made a good living at it from the numerous persons who annually mislay or forget the combinations to their safes. He had done the thing several hundred times. He seldom failed. Indeed, I had occasion to send him, at a subsequent time, to a well known lady who had lost the combination of her safe, and he got the thing open in a few minutes, without fuss or ceremony.

Biancolo explained his method of work to me as one reveals a secret without revelation. It is, however, quite plain that he uses a combination of the tactile and auditory senses plus a wide and accurate knowledge of combination locks. If he manages to get the first number, he never fails to arrive at the rest, usually by a simple method of deduction based on long experience and well-known facts about combinations that I had better leave unstated. It may be well to note that the combination locks he has opened, to my knowledge, were all those of office safes or ordinary vaults. Whether he would succeed in the case of a thoroughly modern bank lock I cannot pretend to say.

There is, however, another method by which the combination of any vault may be opened if the burglar has opportunity to get his data in advance. Indeed, this plan of action was used in one of the great bank burglaries in New England in the last generation. If my memory serves it was the famous burgling of the Northampton bank, but I cannot be sure.

Near the closing hour one afternoon, a well dressed, respectable looking stranger presented himself to the officers of the bank and handed in his card, which bore the imprint of a great firm of safe builders and the name of the caller with his title as one of the officials. The bankers admitted him cordially and he began talking with them about their vault. He did not make a direct sales talk but said he was visiting among the banks of the vicinity to study the various vaults and see whether any of the banks were in need of better equipment or changes in their locks. There had been a number of big burglaries in New England and the bankers were glad enough to let the expert examine their equipment.

Accompanied by the cashier, the visitor went to the vault door, which stood open, and turned the bolts with the handle, so that, had the door been closed, it would have been locked, save for the mixing up of the combination. He then took hold of the knob of the dial, delicately, with the tips of his fingers, and turned it slowly to the left until he felt the first tumbler in position. He then shifted it a trifle further to the left and reversed the knob, turning to the right two turns and again carefully feeling the second tumbler into its place. He now shifted this tumbler a little further to the right and reversed again for the third tumbler. Having found this, he carelessly turned the handle and saw that the bolts were released. He then mixed up the combination in an offhand way, said that the lock was an excellent one and in fine repair, and went his way after a few compliments.

The bankers felt, after the pleasant call of this well informed gentleman, that they had no reason to worry. Had he not said that their vault was above suspicion? Alas, there was a rude awakening. The bankers came down to their rooms one otherwise pleasant morning to find that the combination had been opened as if by magic, the chest entered by means of keys and explosive and a huge total of cash and bonds abstracted. Suspicion fell on employees, on officers, on everyone but the civil gentleman who had called a few weeks before. It was only when the safe makers were summoned and disclosed that there was no such person connected with their company that eyes were turned in the correct direction.

The visitor had, in fact, been one of the master burglars of his day. While he had stood at the vault door, chatting pleasantly with the cashier and apparently examining the lock, he had really got the numbers of the combination and noted them mentally. When he turned the dial left and felt the tumbler in place he took the first number, and so with the second and third. He could, of course, not have done this had the dial been in the locked position when he began his work.

The gullibility of the cashier of that old bank, long ago, cost his institution more than half a million, and bankers ever since have been careful to see that such a trick be not repeated—by a plausible stranger or by someone on the inside.

Our Psychic Investigation Advances

(*Continued from page 139*)

Nino's trance if the latter is genuine, certainly was not observed. But Dr. Prince, while granting the validity of the analogy between hypnosis and sleep for ordinary subjects, feels that Nino is not such a one, and that in his case Dr. Block underestimates the possibilities of long practice. Nino has been in trance literally hundreds of times; and Dr. Prince feels that he has acquired an educated subconsciousness, a sort of genius for trance, of which the ability to associate ideas is merely one aspect. If I am privileged to form an opinion on this very abstruse subject, I should be inclined to support Dr. Prince's views of the possibilities of oft-practiced submergence of consciousness.

All opinion save Houdini's is that Nino was in a valid trance at the end. Dr. Prince regards this trance as extending throughout the sitting. There is no question but that Nino is sufficiently hysterical and sufficiently suggestible to hypnotize himself into going in trance and impersonating Palladino and attempting to work with the apparatus. In such a trance, any suggestion put forward by Vecchio or any other sitter would be seized and acted upon, if possible and consistent. There is no question that, if this is what happens, Nino will struggle with the bonds until he gets free or is exhausted, in the attempt to execute this suggestion—equally whether it is auto-hypnotic or comes from outside. The attempt to prevent examination of the incriminating undershirt, it is to be emphasized, is in no way contradictory of this theory—this could be done subconsciously quite as well as consciously, and indeed is exactly what would be expected from one engaged in subconscious fraud.

The subcommittee in charge of Nino's case consists of Drs. Prince and Carrington, and Houdini; and the opinions of Drs. Block and Stearns receive so much consideration that these gentlemen might almost be regarded as voting members of the subcommittee. If this body were obliged to report finally upon Nino's mediumship at this time, they would feel that the only possible verdict was one of subconscious fraud; and they would feel that the facts cited in this narrative were sufficient to support such a verdict. At the same time, they feel that they have not exhausted the scientific interest of the case, and they would be quite willing to sit further, and to withhold their verdict until after such sittings. The suggestion for further sittings came originally from Dr. Vecchio, at a time when he had expressed dissatisfaction with some of the conditions prevailing at the series here reported. The committee will regard such sittings as in the nature of an appeal against the verdict indicated above—such appeal is provided for in our conditions as promulgated in our issue of January, 1923. In justice to the medium, therefore, no formal and final statement by the committee is made, pending the issue of the new sittings.

The Heat of the Earth

(*Continued from page 98*)

well a cable is necessary, that used in the above tests consisting of a steel aviator wire and two enamelled copper wires, each inclosed in a double thickness of cloth insulation. Cable of this kind weighs 20 to 25 pounds per 1000 feet and is lowered and raised by special hand-operated machinery. For lower depths than 4500 feet the use and handling of this kind of cable becomes rather too expensive and a mercury thermometer of the maximum type has taken the place of the electrical resistance instrument. Usually two or three mercury thermometers are lowered in the same tube or bomb so that a double check on the readings may be obtained. Every care has to be taken to keep these maximum thermometers upright and to prevent their knocking against the side of the hole when they are being drawn up. In summer, when the temperature at the top of the ground is much higher than in the first two or three thousand feet of the well the thermometers have to be cooled with ice before being lowered. Fortunately for the convenience of the measurer using these maximum-type instruments, the temperature invariably increases with greater depth and never falls lower, whatever the rate of increase may be.

In mining operations the increase in heat as the lower levels are reached has long been one of the problems with which mining companies have had to contend, not only because of the discomfort of the mine workers

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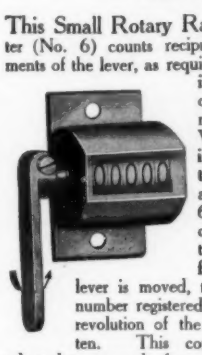

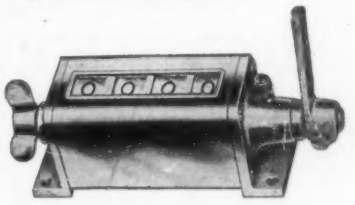

The above Revolution Set-Back Counter records the output of any machine where a shaft-revolution indicates an operation. Sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figure-wheels, as illustrated, $10.00—subject to discount. *Cut less than one-half size.* Set-Back Rotary Ratchet Counter, to record reciprocating movements as on punch presses, $11.50 (list).

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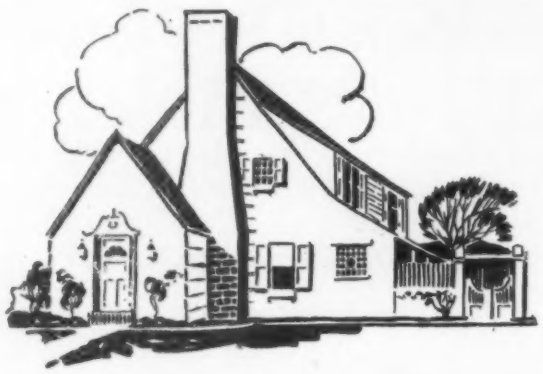

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but also because of the danger of accidents when the combined heat and pressure have reduced the alertness and carefulness of the men. In the deepest mine in the world, the St. John del Rey gold mine in Brazil, which has reached a depth of 6726 feet below the top of the ground, the problem became so acute some years ago as to threaten the closing down of the mine entirely. The men became sluggish and dull and more and more careless in taking precautions. Accidents increased until the death rate averaged more than one a month, and it began to be difficult to get not only laborers but skilled professional workers as well to go to the bottom levels. The problem was solved by the building of a cooling plant at a cost of nearly half a million dollars, which drives air into the shaft at a temperature as low as 43 degrees. Even with such devices as this, however, mines in many parts of the world would have difficulty in operating at this depth, as the rate of increase in temperature in the Brazilian mine has been only about one degree in 125 feet.

With Camera and Chisel

(*Continued from page 106*)

of one marking to fall directly upon that of the other, the surface thus receiving the light will occupy the same position as the corresponding surface of the model or subject, when the photographs were taken. Thus it may be seen that by building or carving the material until the corresponding markings of screen and record photograph coincide over the whole surface, a true reproduction of the form of the subject will be the result. The work of modeling or carving is done by hand under the guidance of the projected light beams, which carry the true form of the subject to the sculptor, but there is nothing in the process or apparatus to bar him from modifying the statue as he pleases.

The size of statue is regulated by varying the distance from center stand to camera-projectors, after the record photographs have been obtained. This is made evident by some of the accompanying illustrations. Within reasonable limits, all sizes of reproductions may be made from a single set of record photographs.

The experiences of the model or subject are very pleasant in comparison to the tedious posing required by the old methods. Only a few minutes are required for the taking of several complete sets of record photographs, including the illuminating photographs which are sometimes used in the form of tinted slides for illuminating the finished statuary, by projection.

This process is adaptable to the production of practically all classes of statuary, in all sizes, and is especially useful in copying and enlarging sketch models or any other existing statuary. One of the most valuable features is the case with which the record photographs of persons or objects may be taken and stored for safe-keeping, until needed for the production of statuary at a later time.

The Story of Steel—II

(*Continued from page 109*)

the machine, which makes a cut 40 feet deep and 175 feet in width. Sixteen tons a minute means nigh upon a thousand tons an hour, and the tracks are so laid and the train so manipulated that the work of the shovels goes on, except for repairs, uninterruptedly night and day for eight months of the year.

With these figures in mind, we are prepared to learn that the Hull Rust mine alone, during the great activity of 1916, shipped out 7,665,611 tons of ore, or over 10 per cent of the total of 75,167,672 tons mined in the United States. The magnitude of the Missabe range mines, in comparison with the others in the Lake Superior district, is shown in the following record of output for the busy years of 1918, when the total output from Lake Superior was 62,836,172 tons. The shipments were: Vermilion, 1,192,908 tons; Cuyuna, 2,478,800; Marquette, 4,354,297; Menominee, 6,378,698; Gogebic, 7,936,701, and Missabe 40,396,711 tons.

An estimate several years ago by the United States Government of our national wealth placed it at 220 billions of dollars; it may well be 250 billions today. If the writer were asked to name the principal agent in the enormous growth in wealth of this country during the past two decades, he would unhesitatingly name the vast iron deposits of the Lake Superior region and the consequent phenomenal growth of our steel industry.

Agriculture? But agriculture depends upon steel for the farming machinery that makes it possible.

Our vast railroad system? Dependent upon steel for locomotives, cars and the rails upon which they run.

Shipping? All now built of steel.

Our enormous factories? Steel framed and fitted with engines, lathes, tools, big and small—all fabricated from the steel and iron of the blast furnace and the foundry.

Our cities, with their towering buildings housing many of them a whole townful of people. Steel girders, columns and plates made them possible.

The future historian will surely designate our era as the Age of Steel.

The Heavens in February, 1924

(*Continued from page 110*)

Auriga high on the right. Perseus, Andromeda and Cassiopeia are in the northwest. Cepheus and Draco are in the north, below Ursa Minor, with Ursa Major in the northeast. Leo is well up in the east, and Arcturus and Spica have just risen. Hydra and Corvus, in the southeast, complete our list.

The Planets

Mercury is a morning star all through the month, and is best seen about the 5th, when he is 25° from the sun and rises at 5.45 A. M. Venus is an evening star and is becoming more and more conspicuous. In the middle of the month she remains in view until 8.30 P. M. Mars is a morning star in Scorpio, rising a little before 3 A. M. Jupiter is close by, and on the 13th the two planets are in conjunction, less than half a degree apart. Saturn is past quadrature and rises at 11 P. M. in the middle of the month. Uranus is an evening star, but too near the sun to be seen. Neptune is in opposition on the 8th, in 9h. 26m. 8s. R. A. and plus 15° 20′ 6″ declination; at that time he moves 6.6s west and 32′ south per day. This puts him on the western edge of Leo, in a region where it will be very hard to find him without an equatorially mounted telescope.

The moon is new at 9 P. M. on the 4th, in her first quarter at 3 P. M. on the 12th, full at 11 A. M. on the 20th, and in her last quarter at 8 A. M. on the 27th. She is nearest us on the 20th, and furthest away on the 12th. During the month she passes near Mercury on the 2nd, Uranus on the 6th, Venus on the 7th, Neptune on the 19th, Saturn on the 24th, and Jupiter and Mars on the 28th.

A total eclipse occurs at the February full moon, but as might be judged from the hour of that phase, it is invisible in the United States except in parts of Alaska. The whole eclipse is visible in Asia, and its close in Europe. This eclipse is noteworthy for its long duration, totality lasting an hour and thirty-eight minutes. This is because the very center of the earth's shadow falls upon the moon—though not in the middle of the latter.

The Blue Ribbon of the Atlantic

(*Continued from page 104*)

over 600 miles, and on one day ran 617 miles, which is the record for one day eastward or westward on this route. In making this day's run, she showed an average speed of 24.92 knots.

In 1913, the writer saw both the "Leviathan" and "Majestic" under construction at Hamburg, and he was informed by their designer that they were identical ships in model, accommodation, and motive power, but that the "Bismarck" ("Majestic") was six feet longer than the "Vaterland" ("Leviathan"). This additional length was given the vessel, he stated, so that the Hamburg-American Company might possess in the "Bismarck" the largest ship afloat. The greater length was secured by introducing two additional frames amidship. Since the displacement of the additional amidship body on a draft of 39 feet is 700 tons, the "Majestic" exceeds the "Leviathan" by that amount, her displacement being 64,800 tons as against a displacement of 64,100 tons for the "Leviathan." The "Leviathan" and the "Majestic" have the same turbine equipment, but the bigger ship carries two additional boilers, the "Leviathan" having 46 and the "Majestic" 48 water-tube boilers. The "Majestic" holds the record to the eastward with a passage of 5 days, 5 hours, 21 minutes, which was made at the record speed of the whole trip of 24.76 knots. Her best day's run of 609 miles was made to the westward. Her best all-day run to the eastward of 603 miles, was made at a speed of 25.66 knots.